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AUSTRALIAN CONSOLIDATION LOCOMOTIVE.

THERE is no quarter of the British empire where a visiting American feels more at home and sees so many familiar sights as in the great island continent of the southern seas known as Australia. The cities are laid out with broad avenues on the rectangular plan, and they are lined with lofty business blocks, which, while they may not be as high, are built on the same general system as those at home. American cars run on the tracks, and as long as ten years ago there were forty miles of cable road in the city of Melbourne. American hotels, the American buggy, and American ideas in general abound; the people and its cities and public works being a happy combination of what is best in English conservatism and American enterprise. The cause is not far to seek, and is to be found in the fact that the discovery of gold in Australia, which occurred shortly after that in California, brought a large influx of Americans from across the Pacific, mainly from the Pacific coast; and the influence which was then introduced has been strengthened by subsequent intercourse. This is very plainly to be seen in the railroads of the country, both in the rolling stock and the roadbed. The early railways were very wisely built to conform to the topography of the country, and a curvature and gradients were used in laying out the lines which were greatly in excess of anything used in England. There are stretches of line with a gradient of from 1 in 30 to 1 in 75; and originally the freight and heavy passenger trains were worked by double headers, after the usual English practice.

The recent report of the Railway Commissioners of New South Wales to the Minister for Railways says: "Immediately upon our taking office, in 1888, we found the lines were most exceptional in their character, having been constructed with an enormous proportion of steep gradient—631 miles of grades, varying from 1 in 30 to 1 in 75—the worst grades being on the trunk lines, and so situated that the whole volume of traffic passed over them. We therefore decided upon reducing some of the steep gradients, and introducing more powerful locomotives." This was done; and several heavy American consolidation engines, built by the Baldwin Locomotive Works, were introduced. They had cylinders 21 in. diameter by 26 in. stroke; 160 pounds steam pressure; 1,999 sq. ft. heating surface, and the engine and tender together weighed 97 tons 3 cwt. The report goes on to say, "By these means, great economy in the working, as well as in the expediting of traffic, have been effected, and from a recent careful computation it is estimated that the saving per annum at present being realized—and which will continue for all time—is a sum of more than $500,000; and, of course, as the traffic increases in volume so will the annual saving be increased. The saving in train and assistant engine mileage for the current year, taking the hauling power of 1888 for comparison, is 900,000 miles.

"Another important feature in connection with the introduction of long trains, consequent on this altered policy, seeing that nearly 2,400 miles of our railways are single lines, is that the largely reduced number of trains necessary to convey the traffic under the altered state of things will postpone for years to come the duplication of lines that would have been necessary, at an enormous expense, under the old system. . . . The American consolidation engine can haul a train of 350 tons on a grade of 1 in 40 at 10 miles per hour, 620 tons on a grade of 1 in 100 at 15 miles per hour, and 650 tons on a grade of 1 in 150 at a speed of 18 miles per hour. . . . In 1891 these powerful engines first began to work, and since that date the gross and net earnings per train will have been largely increased." In 1890, with the lighter engines, the net earnings were 58 cents per train mile, whereas in 1894 they had increased to 85 cents, and the net increase for the years 1891-94, inclusive, amounted to nearly $5,000,000.

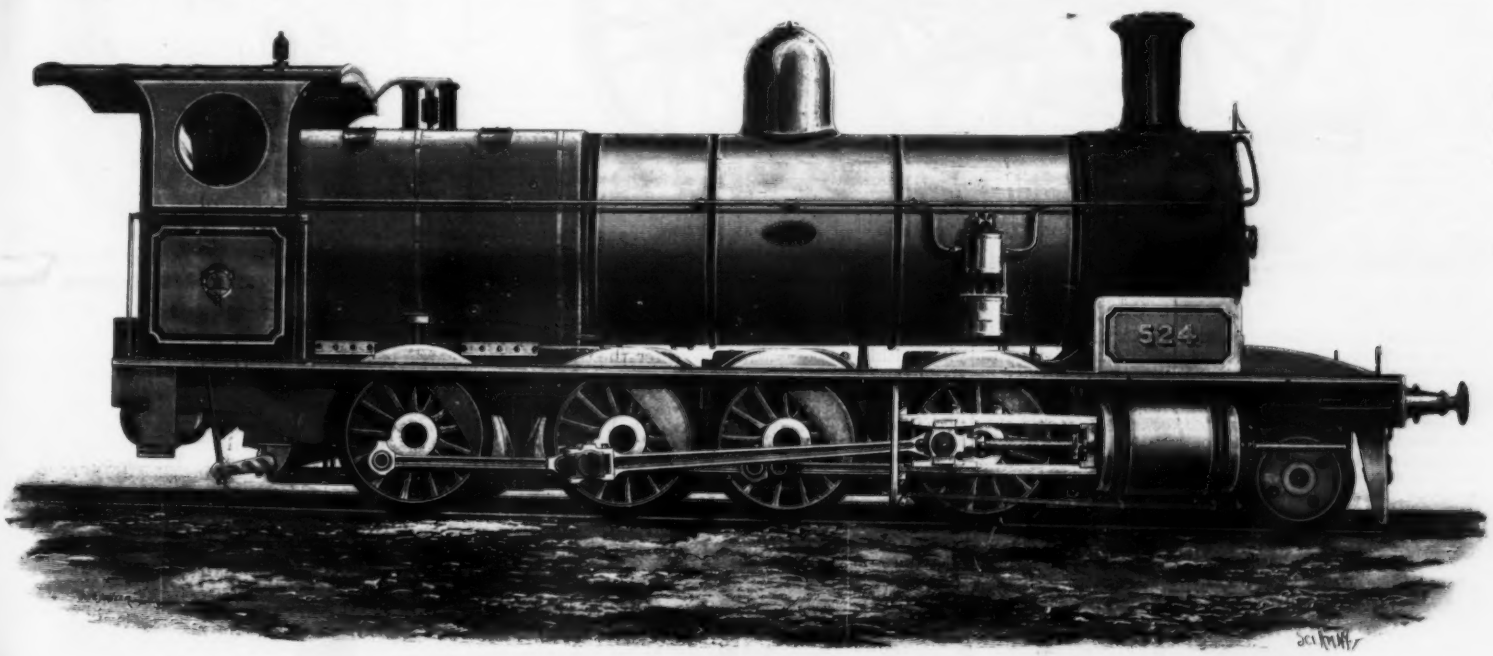
The accompanying illustration shows the latest type of locomotive built for the New South Wales Railways, of which the commissioners say, "This type will, we believe, be one of the most satisfactory engines for goods [freight] trains, working on lines with heavy grades, ever constructed, as it embodies the careful combination of all the best qualities of the American and English locomotives. We have been able to effect this result, as a large number of engines of both classes have been in use on these lines for many years, and our locomotive officers have consequently been able to study and appreciate the relative qualities of both types under all conditions." The details of this fine locomotive are as follows:

Diameter of truck wheels	2 ft. 9½ in.
" " drivers	4 " 3 "
Cylinders	21 in. dia. by 26 in. stroke
Heating surface, tubes	2,045 sq. ft.
" " firebox	166 " "
Total	2,211 " "
Grate area	20¾ " "
Boiler pressure	160 pounds per sq. in.
Weight, locomotive	62¾ long tons
Tender	41 " "
Total	103¾ " "

The hauling power is as follows:

Grades.	Tons.	Speed per hour.
1 in 40	350	10 miles
1 " 75	615	12 "
1 " 100	700	15 "
1 " 150	750	18 "

It will be seen that this is not so powerful an engine as the Lake Erie decapod locomotive illustrated in the SCIENTIFIC AMERICAN of last week, which weighs 96 tons, say 84 long tons, as against 62¾ tons for the Australian engine, and has 2,443 square feet of heating surface, as against 2,211 square feet.



AUSTRALIAN CONSOLIDATION LOCOMOTIVE (1894) FOR THE NEW SOUTH WALES GOVERNMENT RAILWAYS.

Cylinders, 21 in. diameter by 26 in. stroke; steam pressure, 160 pounds; heating surface, 2,211 square feet; weight, 103¾ tons.

A curious addition has just been made to the list of state monopolies in France. The liquid resulting from the washing and soaking of tobacco leaves, which is used by farmers and horticulturists as an insecticide, will henceforth be sold in sealed casks by the government tobacconists.

ROAD LOCOMOTIVES AND PORTABLE ENGINES AT THE LEICESTER SHOW.

WE present some engravings of portable engines and road locomotives which were exhibited at the show of the Royal Agricultural Society of England, which was held this year at Leicester. The portable engines were specially well represented. The 12 horse power portable oil engine constructed by Messrs. Clayton & Shuttleworth, of Lincoln, England, is shown in Fig. 1. This represents their portable engine of 12 brake horse power, which is fitted with a cooling device overhead. In this a draught of air is induced by the blast over and through the circulating water, which is delivered by a pump and made to run over shelves in thin streams. The igniter is kept hot by a blue flame lamp, supplied with oil by a pump. The vapor valve and the oil pump are both worked off one crosshead by a hit-and-miss motion operated by an inertia governor. In another form of this engine, ignition, when running, results from the heat of the combustion chamber. There is a horizontal ignition tube, which is heated in the first instance by a blowing lamp, but when the engine is started this lamp is removed and the tube is no longer needed. This is a very important step in the direction of simplicity, and also of economy, for a lamp consumes several pints of oil per day, no matter whether the engine is lightly or heavily loaded. We understand that in future all Messrs. Clayton & Shuttleworth's engines will be built on this design, which presents a very simple and neat appearance. A centrifugal governor is used in this engine.

Comparatively little animation is shown in connection with steam engines, and that is mostly directed toward traction engines and agricultural locomotives. For the first time in their history Messrs. Ransomes, Sims & Jefferies, Limited, of Ipswich, exhibit a road locomotive at the Royal Show, although they have built a considerable number. This engine, which we illustrate in Fig. 2, is of 8 horse power, and well supports the reputation of the makers. We are informed that one of the same type and power has been daily hauling a load of coal and timber, weighing, with the trucks, 34 tons, up a long incline of 1 in 12, the gross weight of the train being 47 tons. It also draws 25 tons, in fast gear, at the rate of four miles an hour, up a gradient of 1 in 12, of about a mile in length. The only point in the design to which we need call attention is the fore tank beneath the boiler barrel for carrying an extra supply of feed water. The two tanks are connected by means of a pipe, and a cock, capable of being operated from the footplate, enabling the connection to be shut between the two tanks when traveling up hill. An injector draws its supply from the hind tank. The same firm show, also for the first time, a vertical high speed engine designed to drive a dynamo, or a fan, or a centrifugal pump. It is neatly designed, but one is struck at first sight with the very large proportions of the crank pin and bearings. These have been made of large size to enable the engine to be fed with steam from boilers supplying triple expansion engines. When relatively low pressure steam is to be used, larger cylinders are fitted. These engines are made in six different

sizes, and the one shown is fitted on a cast iron bedplate together with one of Norton's patent vertical multitubular boilers. These boilers are fitted with horizontal tubes, and an uptake outside the boiler, so that there is no heating surface above the water line.

The automatic expansion of the vertical engine is controlled by the shaft governor shown in the illustration in Fig. 3. The centrifugal weights are pivoted at the back of the disk and are controlled by springs in the usual way. Studs fixed in them come through the disk, and are connected by links to a circular flanged plate carried in a bearing which looks remarkably like an eccentric strap. The strap, or rather one-half of it, is fixed to the main disk and embraces the plate within it. The plate is cut away in part to allow one of the studs on the weights to come through, and hence there is some little difficulty in recognizing it in the engraving, although its flanged edge fitting in the strap is plain enough. On the front of the plate the eccentric is fixed; it is, of course, under the control of the centrifugal weights, which, in moving outward, rotate the plate within its bearing, and so alter the throw of the eccentric. The very large bearing around the flange of the plate affords the friction necessary to give steadiness to the eccentric under the varying resistances opposed to the motion of the valve.

A new shaft governor is shown by Messrs. Robinson & Auden, Limited, of Wantage. This is entirely different from all other governors of the same type. In it the features which led to the great success of the Pickering governor, that is, entire absence of pins and joints, are applied in a different fashion, but with the same object. The springs are formed of steel blades laid into a laminated spring, and the weights are connected to the centers of these springs, either directly, as in the small high speed governor, or by steel bands in the low speed large diameter governor. The eccentric is guided by two steel bands, which form a jointless parallel motion, and hence neither weights nor eccentric have pin pivots. The two springs, which stand opposite to each other, thus ( ), are connected to a fixed block at the lower end and to a block sliding under considerable friction at the upper end. This block is connected to the eccentric by a steel band. When the two weights move outward under centrifugal force the springs are bent to a shorter radius, and the block

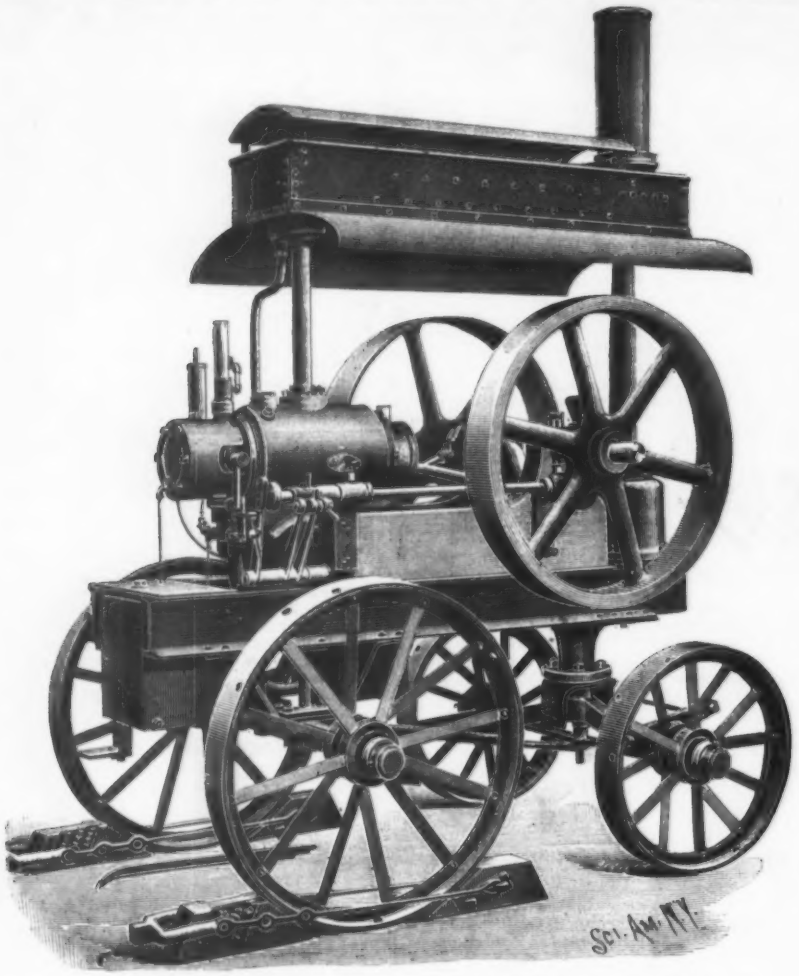


Fig. 1.—TWELVE HORSE POWER PORTABLE OIL ENGINE.

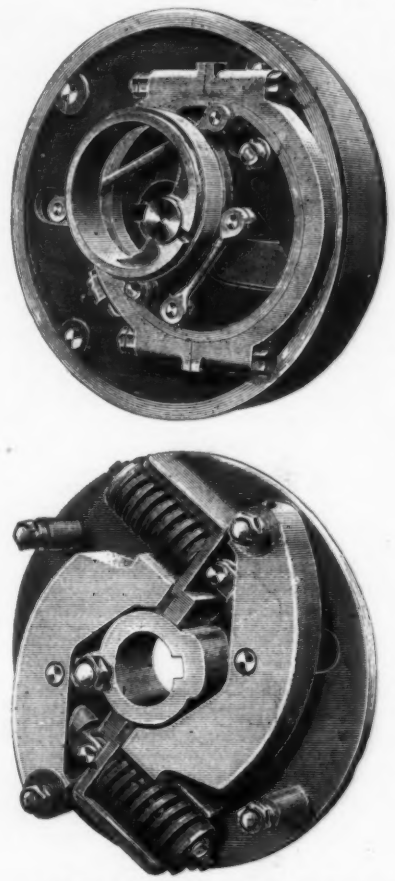


Fig. 3.—SHAFT GOVERNOR FOR HIGH SPEED ENGINES.

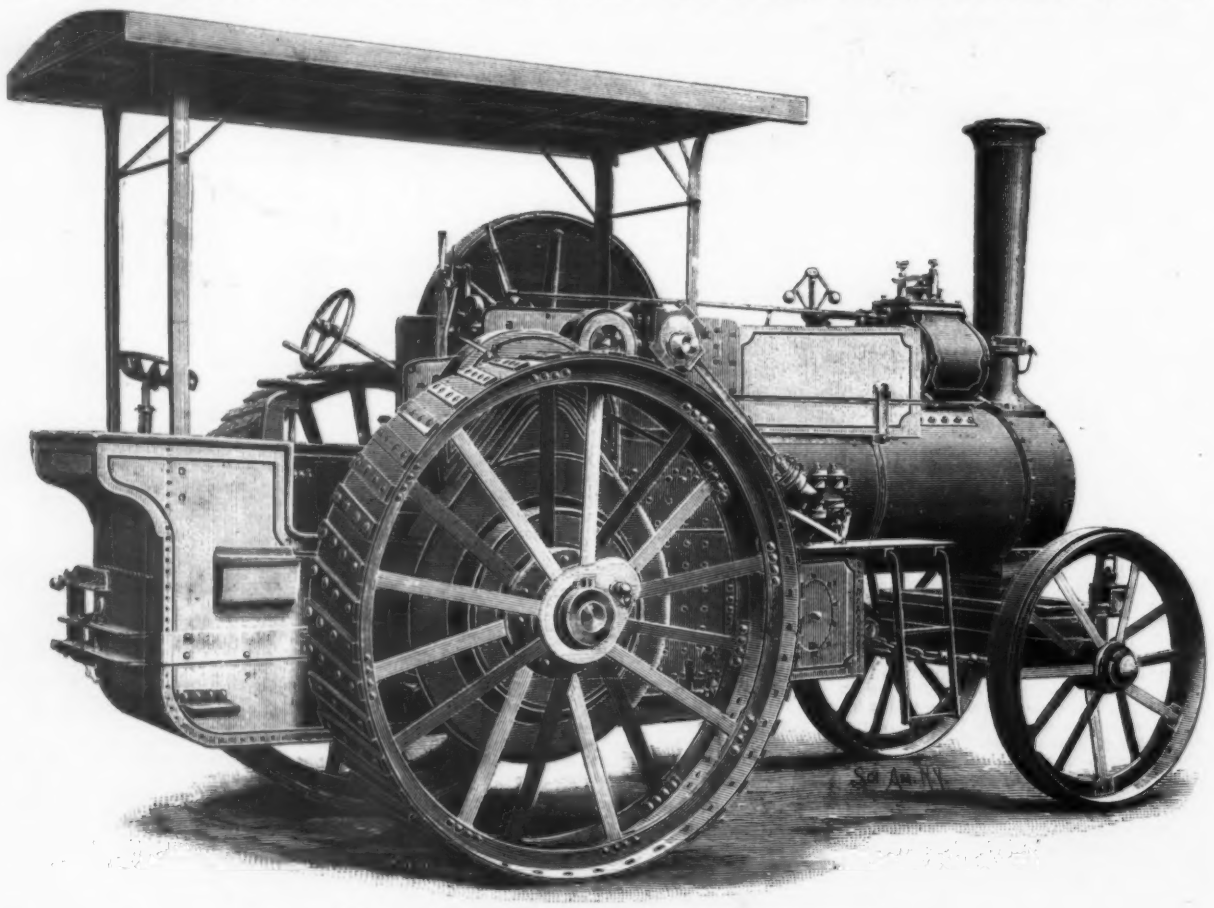


Fig. 2.—EIGHT HORSE POWER ROAD LOCOMOTIVE.

moves toward the center, reducing the throw of the eccentric, which lies against the face of the flywheel. It is held in position by bolts and distance pieces which pass through holes in the wheel to a ring on the other side. We hope shortly to illustrate this novel governor.

Messrs. Charles Burrell & Sons, Limited, of Thetford, devote a large amount of attention to supplying traction engines to the owners of shows and merry-go-rounds, and do a very large business with this class of men, who are much larger capitalists than some people might imagine. At the present show they have two very large engines—of 10 horse power and 8 horse power—designed for this trade. They are used to draw all the vehicles carrying the various structures, and are fitted at the forward end with a dynamo, which is used to light the show ground by means of arc lamps. In this way they are rendered useful, both on the road and

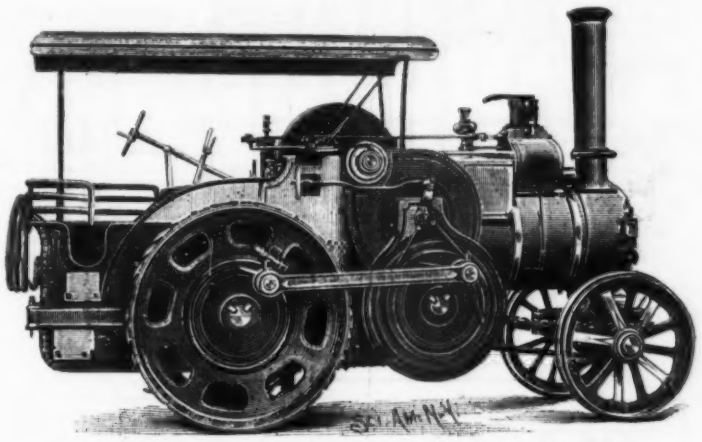


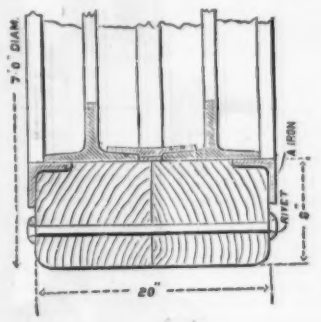
FIG. 4.—SEVEN HORSE POWER ROAD LOCOMOTIVE.

during the fair, at least after nightfall, which is the busiest time. The larger of the two engines is fitted with a steam brake in addition to the ordinary screw brake. It is usual in traction engines to place the brake on the second motion shaft, on which is the compensating motion, and hence it does not get a positive hold. It may be relied upon to control one wheel, but the other is free to move. Hence in coming down a hill, with a very heavy unbraked train behind, the safety of the engine depends on the steering wheels keeping the engine from slewing sideways. As there is not a great weight on these, it is possible, on a slippery road, for them to slide sideways upon the sudden impact of the train on the rear of the engine when one wheel is braked. This is, of course, a very dangerous accident if the engine be moving, and to prevent it Messrs. Burrell have applied a brake block to the inside of each driving wheel, and have fitted a steam cylinder by which the blocks can be instantly and firmly applied, even if the pressure of steam be low. A special angle iron is riveted inside each wheel for the block to press against. The 10 horse power engine has driving wheels 7 ft. in diameter, and attracts a great amount of attention by its fine appearance. It is, of course, compounded, like nearly all Messrs. Burrell's engines, and is mounted on springs, according to a method described in former reports. The leading end of the engine is mounted with rubber rings which are always in compression. These serve to modify the shocks from a glance from Fig. 4. Instead of driving direct on to the main axle, the power is led through gearing on to a cross shaft in front of the fire box, there being the usual fast and slow speeds. At each end of this shaft there is a crank disk, and a coupling rod connecting it to a crank disk on the driving axle. On each driving wheel is a friction band, which makes the connection between the wheel and the disk and allows the wheel to slip a little in rounding curves. The entire engine is narrow, and therefore the difference in speed between the two wheels is not so great as in broader engines. The advantage sought in this design is the ability to put elliptical springs on the main axle without the use of any elaborate arrangements to prevent the toothed wheels getting out of gear. We are informed that the engine of this type previously built has traveled 30,000 miles over very heavy roads.

For our engravings and the foregoing particulars we are indebted to Engineering.

TRACTION ENGINE WITH WOOD RIMMED WHEELS.

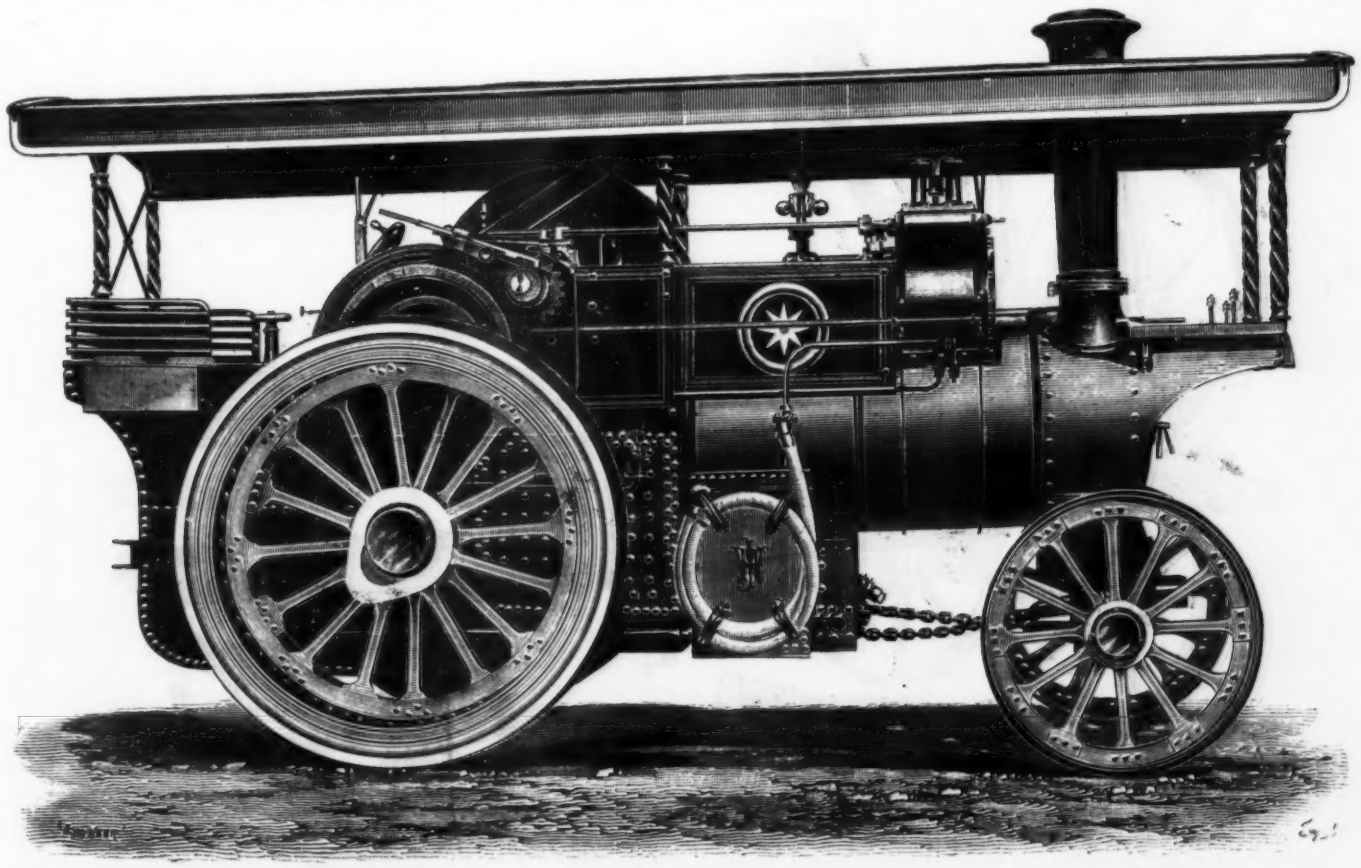
WE illustrate from London Engineer a traction engine, shown by Messrs. Burrell at the Crystal Palace. The principal feature of novelty in the engine is Mr. F. Burrell's patent wood block wheels. The engine at the palace is a light 6 horse power compound road locomotive weighing 7 tons, and capable of hauling 17 tons gross load up 1 in 15, and working on from 3 to 4 cwt. of coal for a day's run. The engine is double geared; that is, each wheel is driven independently with compensating gear on the countershaft. The engine is not on springs. The engine we illustrate is one of thirty-five supplied to leading showmen in this country, and is provided with a dynamo support in front. It will indicate 50 horse power, and is capable of hauling 50 tons through any part of this country. The water supply lasts from nine to twelve miles at speeds from four to six miles per hour. The diameter of the driving wheels is 7 ft.; width of driving wheels, 20 in. The rims are of oak blocks set endwise of the grain. They are 7 in. deep, supported by angle irons and wrought rings on each side, with a rivet through each block from side to side, as shown in the cross section. The engine is compound, with a single balanced



crank. It is mounted on springs—Burrell's patent system, which has now been applied to over 300 engines, and stood the test of eight years. The brass fittings shown in the engraving are in accordance with showmen's requirements.

COMPOUND BLOWER.

WE illustrate on next page a type of fan recently introduced by Messrs. Hodges & Company of Cazenove Road, London, N. The general appearance of the machine is well shown in Fig. 1. The engine is mounted on a short column casting on the fan casing, and drives the latter by means of a link belt, which is kept tight by means of a spring-mounted tension pulley. The tension can be adjusted when desired by means of the handle shown at the front of the machine. The engine, which is double acting, is of the inclosed type, and its crankshaft, eccentric, etc., all run in an oil bath. The bearings are of phosphor bronze, adjustable vertically, and are very long, so that, once started, the engine will run a very considerable time without attention. The slide valve is of the piston type, and is perfectly balanced. The cylinder, which is 8½ in. in diameter, is fitted with relief valves, drain cocks, and a sight feed lubricator. Special attention has been paid to balancing the moving parts, so that the engine, in spite of its elevation above the base of the combination, runs remarkably steady at a speed of as much as 500 revolutions per minute when driving the blower, and can be run idle at over 1,200 revolutions per minute without sensible vibration. The principal novelty in the arrangement is, however, in the construction of the blower, which is "compounded." As will be seen from Fig. 2, it is divided into five chambers, arranged in two pairs, at either side of the pit or delivery chamber. In each of these chambers is a fan, all the fans being mounted on the same



COMPOUND TRACTION ENGINE.

spindle. The two outer chambers, A, A, collect the air from outside the machine and deliver it at E, E, whence it is directed by radial guide blades, and delivered to the second wheels, B, B, at D. These latter wheels, it will be seen, are of smaller capacity than A, A. In a similar way the air from this second pair of wheels is delivered to the central pair, which sends it on through F, F, to the blast pipe. On leaving the first pair of wheels the air is in a state of rapid rotation, but the guide blades, already referred to, direct it toward the openings of the second pair of wheels, converting much of this energy of rotation into pressure in the process. The consequence is that the air on entering the second pair of wheels is already at a pressure higher than that of the atmosphere. This, again, is further enhanced by the action of this second pair of wheels, so that as finally delivered from the central wheel the air has a pressure which, under favorable conditions, is as much as 30½ oz. per square inch.

The diagram, Fig. 3, shows, the makers claim, the advantage gained by this method of compounding. The upper curve, A, shows the maximum pressures obtained at the speeds indicated below it. Thus at the maximum pressure of 30½ oz. the revolutions of the fan number 2,600 per minute, while at 1,400 revolutions the maximum pressure is 8 oz. per square inch. The most efficient working pressure is about two-thirds the maximum, and the performance of the blower under this output is shown by the curve, B. The figures in this curve show the cubic feet of air discharged at the stated pressures. Curve C gives similar observations on a good specimen of an ordinary fan. Thus at 1,400 revolutions the blower will deliver 1,440 cubic feet of air at a pressure of 8½ oz. while the ordinary type of fan will only deliver 1,440 cubic feet at a pressure of 4½ oz., and at the higher speeds the contrast is still more striking.—Engineering.

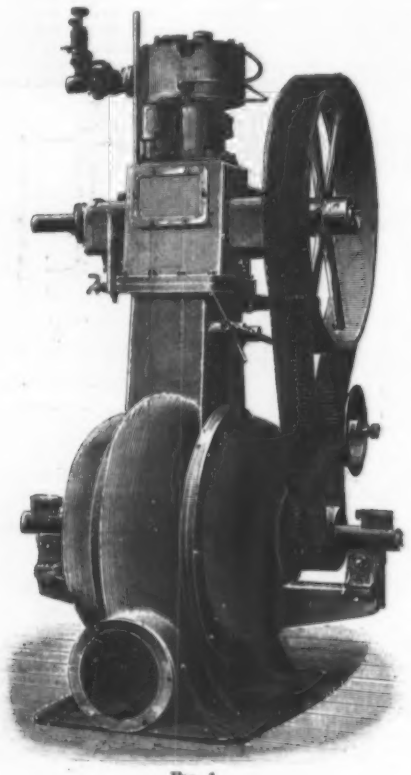
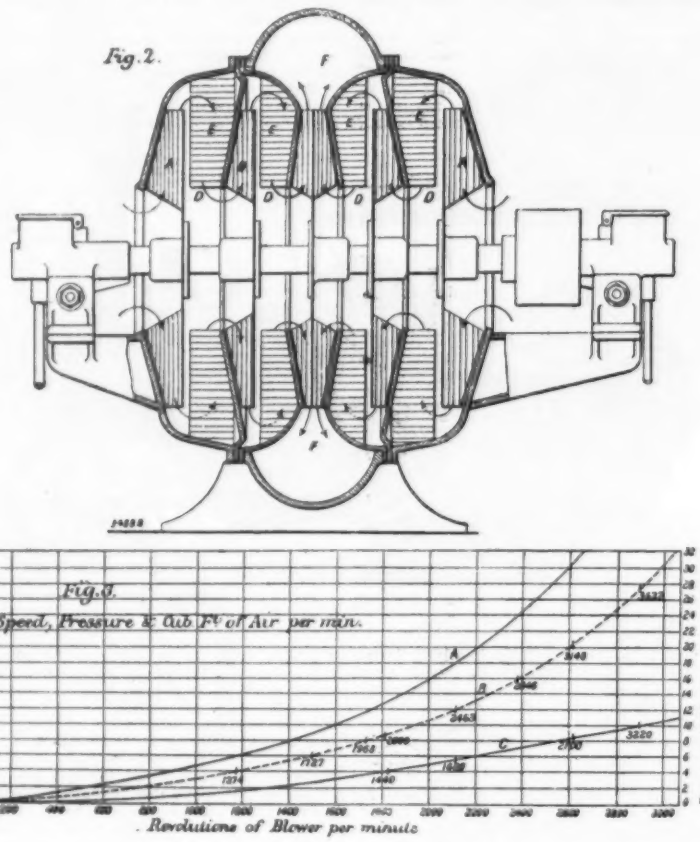


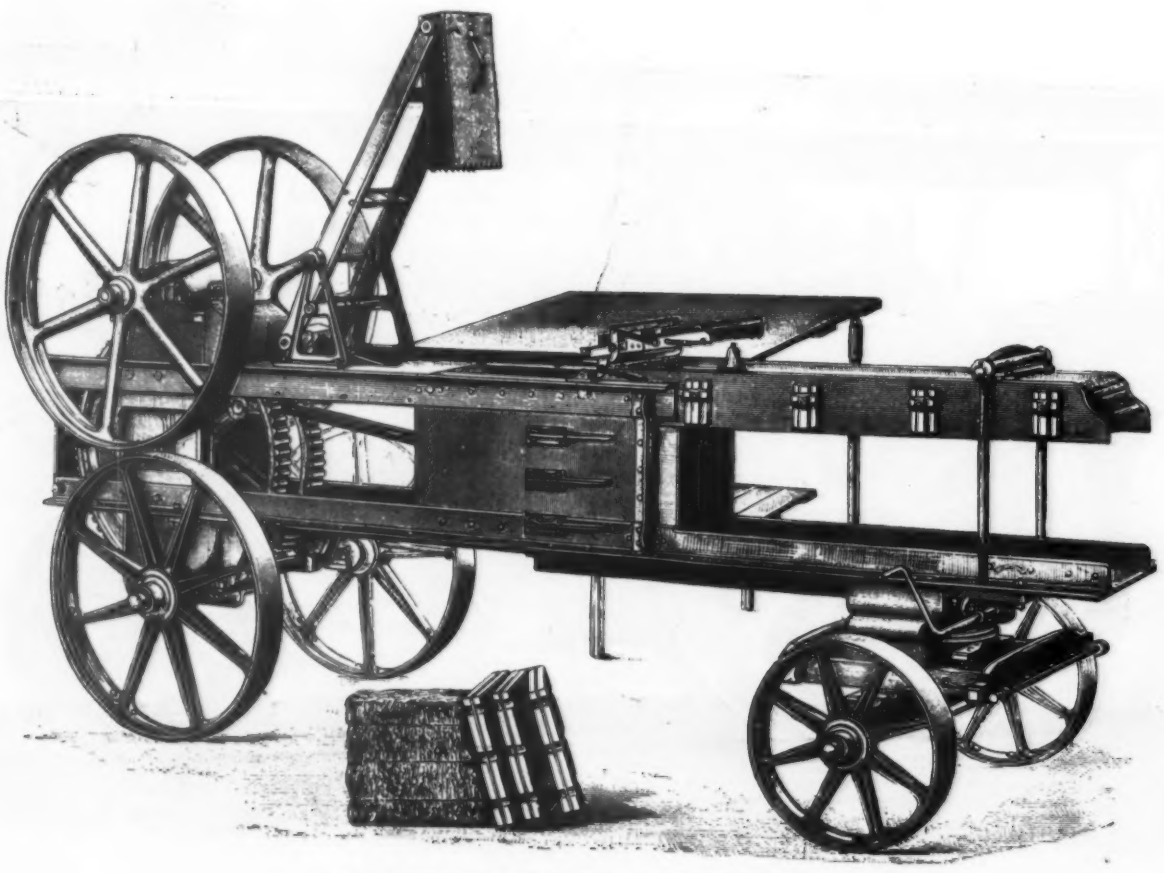
FIG. 1.



COMPOUND BLOWER.

SELF-FILLING PERPETUAL BALING PRESS.

OUR illustration below represents a baling press for hay and straw with a new self-feeding arrangement and automatic hinged dropper, made by Messrs. J. & F. Howard, of Bedford. The general arrangement of the machine will be familiar to most readers, who will also be aware of the danger which the operator was formerly exposed to in the old-fashioned hand-fed apparatus. The feed arm, shown in an oblique position in the engraving, is elastically connected to the gearing which drives the ram, so that, as the ram is being withdrawn to the end of its travel, the feeder arm descends and carries with it the hay or straw into the baling chamber, and while the ram advances, the feeding arm rises clear above the press. The workman, standing at the side of the press, has only to push the hay or straw over the open chamber and to place a follower in the dropper frame while turned back. The frame then being raised, the feeder arm, in descending, releases the follower and guides it into position ready for the ram to push it past the retainers. With a four or five horse power engine a pressure of twenty-five pounds per cubic foot can be obtained on the material being baled. We are indebted to English Engineer for the cut and copy.



SELF-FILLING PERPETUAL BALING PRESS.

[Continued from SUPPLEMENT, No. 1073, page 17153.]

NOTES ON CONVEYING-BELTS AND THEIR USE.*

By THOMAS ROBINS, Jr., New York City.

I WOULD like very much to give some rule for determining the exact number of horse power required for conveying-belts running under different conditions, but I find it impossible, owing to the number of variable quantities which make up the load. One of the most important of these points is based upon the distance between the sets of troughing pulleys. If they are too far apart, the belt sags down between, which materially increases the load. If, on the other hand, the idlers are too near together, the extra number of bearings makes another sort of resistance to be overcome. No general rule can, therefore, be made by which the required horse power can be accurately determined.

It is a simple matter to determine the necessary belt width and speed to perform certain duty when the weight per cubic foot of the material is known. If the belt is troughed, it is safe to estimate that the load itself will cover one-half of the belt's total width, and that the depth in the center will be one-quarter of its own width. The area in inches of a cross section of the load (which we may consider an inverted triangle) will, when multiplied by 12, give the number of cubic inches of material borne by the belt on each running foot of its surface. Multiply this result by some estimated speed to get the quantity in cubic inches that the belt will deliver per minute, and then reduce this to the number of feet, yards, pounds or tons delivered per hour, or to other convenient terms. (See Fig. 9.)

Table Showing the Number of Cubic Feet of Material Delivered in an Hour by Different Widths of Troughed Conveying Belts Traveling at Various Speeds.

SPEED PER MINUTE IN FEET IS SHOWN IN THE LINE NEXT BELOW THIS.

Width of Belt in inches	100.	150.	200.	250.	300.	350.	400.	450.	500.	550.	600.	650.	700.	750.
12	187·5	281·2	375·0	468·7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	255·2	382·8	510·4	638·0	765·6	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	333.3	500·0	666·6	833·3	1000·0	1166·5	1333·2	.....	.....	.....	.....	.....	.....	.....
18	412·8	619·2	825·6	1032·0	1238·4	1444·8	1651·2	1857·6	2064·0	.....	.....	.....	.....	.....
20	520·8	781·2	1041·6	1302·0	1562·4	1822·8	2083·2	2343·6	2604·0	2864·4	.....	.....	.....	.....
22	630·2	945·3	1260·4	1575·5	1890·6	2205 7	2520·8	2835·9	3151·0	3466·1	3781·2	4096·3	4411·4	4726·5
24	750·0	1125·0	1500·0	1875·0	2250·0	2625·0	3000·0	3375·0	3750·0	4125·0	4500·0	4875·0	5250·0	5625·0
26	880·2	1320·3	1760·4	2200·5	2640·6	3080·7	3520·8	3960·9	4401·0	4841·1	5281·2	5721·3	6161·4	6601·5
28	1020·0	1530·0	2040·0	2550·0	3060·0	3570·0	4080·0	4590·0	5100·0	5610·0	6120·0	6630·0	7140·0	7650·0
30	1170·1	1755·0	2340·2	2925·2	3510·3	4095·3	4680·4	5265·4	5850·5	6436·5	7020·6	7613·9	8190·7	8775·7
32	1333·3	2000·0	2666·6	3333·3	4000·0	4666·5	5333·2	6000·0	6666·5	7333·1	8000·0	8666·6	9333·1	9997·5
34	1505·2	2257·8	3010·4	3763·0	4515·6	5268·2	6020·8	6773·4	7526·0	8278·6	9031·2	9783·8	10536·4	11289·0
36	1687·5	2531·2	3375·0	4218·7	5062·5	5906·2	6750·0	7593·7	8437·5	9281·2	10125·0	10968·7	11812·5	12656·2

The following table shows the suitable number of plies for different widths of conveying-belts:

Belts 20 in. wide and less should be 4-ply.
" 22 and 24 in. wide " " 5 "
" 26 " 28 " " " " 6 "
" 30 to 36 " " " " 8 "

The thickness of the rubber cover should be based upon the character of the stuff to be carried. For hard material weighing over fifty pounds per cubic foot, the cover should not be less than one-quarter of an inch in thickness. With the patent reinforced cover referred to above, it is possible to have this thickness at the center where it is needed, allowing it to taper off to one-sixteenth of an inch or one-eighth of an inch at the sides, where the work is lighter. This, of course, makes the cost lower than if the same thickness of cover extended the whole width of the belt. The belt with the reinforced cover referred to is shown in Fig. 10, A. There is now an improved form of this belt which combines the advantages of this thickened cover with stiffened edges which gives it such firmness at that part that a mere touch against the steering idlers serves to keep it running true. This stiffening is done by running two or three plies of duck a part of the way in from the edges, giving all the advantages of a heavier belt, but at a lower cost. This form will also be patented. (See Fig. 10, B.)

Fig. 9.

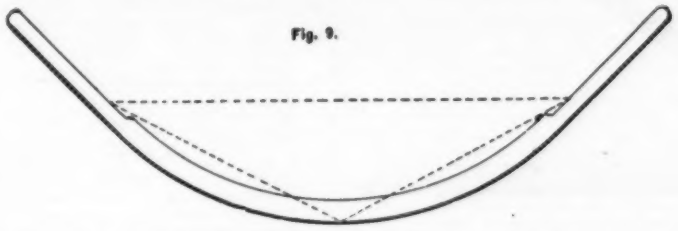


DIAGRAM SHOWING METHOD OF CALCULATING WORKING LOAD.

For example: To find the number of tons of material weighing 100 pounds per cubic foot that can be delivered by a 24 inch belt running 250 feet per minute:

As the belt is 24 inches wide, we may safely consider the load as being a triangle standing on its apex and having a base 12 inches wide and a height of 3 inches. Therefore, the area of its cross section will be 18 inches, and there will be $18 \times 12 = 216$ cubic inches on each foot of the belt. As the speed is 250 feet per minute, there will be delivered from the end of the belt 250 times 216 cubic inches, or 54,000 cubic inches per minute. This is equal to 31¼ cubic feet per minute, or 1,875 cubic feet per hour, weighing 187,500 pounds, or about 93 tons per hour.

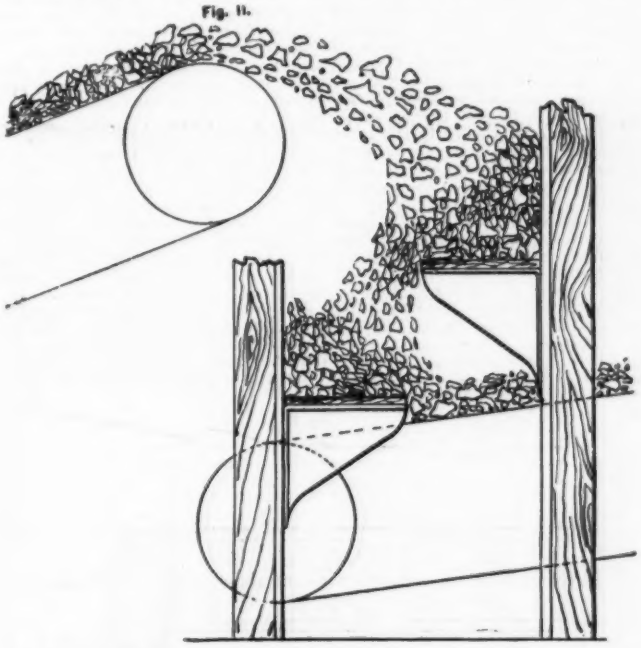
To save some of the steps referred to above, the following formula may be used: If we let A = width of belt, then $\frac{3\,A^2}{8}$ = number of cubic inches carried on each running foot of the belt. If a belt is run flat it will carry about one-third as much or $\frac{A^2}{8}$. It is well to remember that when the width of a belt is doubled it will carry four times as much material, and when it is tripled it will carry nine times as much.

The table herewith will be found of service in determining the capacity of conveyer belts.

In regard to this table I wish to say that the results shown are based upon a continuous and even delivery of fine material to the belt. As this is often unattainable in practice it is well to prepare for uneven and large pieces and for irregular feed by allowing a margin in either belt width or speed, the two factors which govern the capacity of the belt. The widths of belting in most common use are 22, 24 and 26 inches, and the average speed is about 300 feet per minute. I am inclined to favor higher speeds, especially for elevating at an angle, as it requires less power to lift a small sized load at a high speed than the same amount of stuff per hour in a larger sized load at a low speed. A good speed for level work is 450 feet per minute; at an angle 650 feet is not at all too fast; and I have seen belts working smoothly at 900 feet per minute and at an angle of 27 degrees. Such speed as this, however, is hard on both the belt and idlers, and I do not recommend it.

Having decided upon the proper width of belting for the duty to be performed, the next points to be settled are the proper thicknesses for the belt and for its protecting cover.

Fig. 11.



SECTION SHOWING DELIVERY OF COARSE MATERIAL FROM ONE BELT TO ANOTHER.

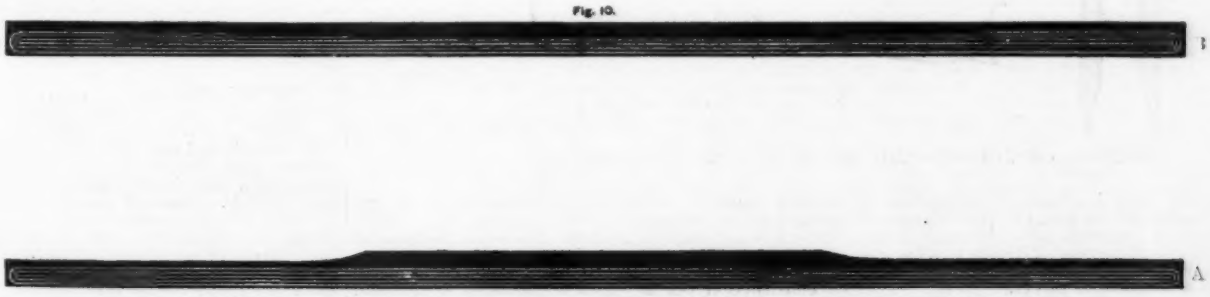
At the point where a belt receives its load it gets as much wear as it meets with in all the rest of its journey. A few points should be borne in mind in connection with this part of the conveyer. The material should not be allowed to drop vertically upon the belt, but should instead be so guided by an interposed chute as to strike the belt with as nearly as possible the same speed, and, of course, in the same direction as that of the belt itself. This is much the same principle as that which causes a man who wishes to board a fast moving car to run along a few feet before jumping upon the step, except that in the former case it is the wear and tear upon the vehicle or belt which is avoided instead of injury to the passenger.

If ore or rock is carried, there is bound to be wear wherever it touches. It is well, therefore, if it has to fall any distance to let its force be broken by striking first against an accumulated pile of itself and then roll off on to a chute, whence it may slide quietly upon the belt and not move until it reaches the end of its journey. (See Fig. 11, which shows the device in use at the New Jersey and Pennsylvania Concentrating Works, Edison, N. J.)

The chute should be made of cast iron with sides, and should be so wide that the ore or other metal cannot get jammed, as it is very apt to do. The objection to a wooden chute is that the broken stone or ore does not slide properly upon it, but runs down in a succession of jumps, that are as apt as not to carry it over the side of the chute or off the belt.

A device is shown in Fig. 12 for loading a belt under a crusher, from which falls both coarse and fine stuff,

Fig. 10.



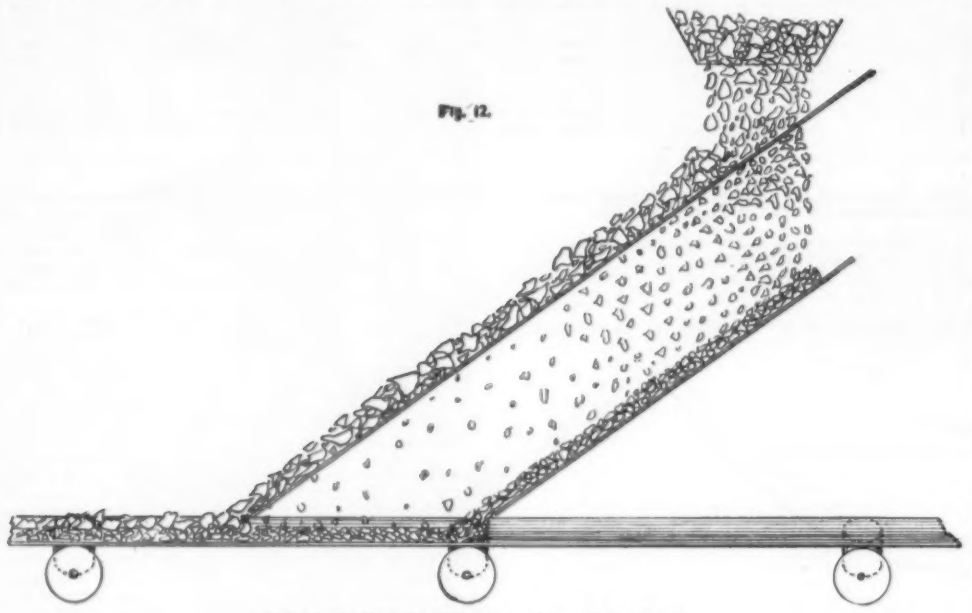
CROSS SECTIONS SHOWING STRUCTURE OF PATENT CONVEYING-BELTS.

* At the Pittsburg meeting, February, 1896, and published in the Transactions of the American Institute of Mining Engineers.

The line, A, represents a grizzly or screen of iron bars which allows nothing larger than one inch to go through. The small stuff slides down the chute, B, and forms a bed on the belt to protect it from the impact of the heavier pieces.

There are many ways of joining the ends of carrying-belts, the most common being by the use of metal belt hooks, consisting of a set of teeth cast together with a metal back. These have to be destroyed if the belt needs taking up, and a better plan is shown herewith in Fig. 13. The thin steel plates are laid upon a strip of thin leather or canvas, which covers the opening in the belt and thus prevents leakage. Staples are driven through the holes in the plate and clinched. In breaking the joint the staples are easily cut with a cold chisel,

Fig. 12.



COMBINATION OF GRIZZLY AND BELT.

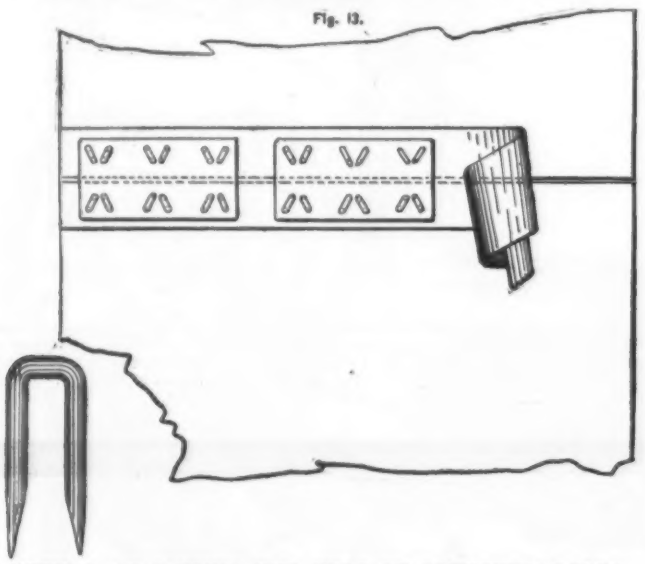
but the plates themselves can be used an indefinite number of times.

The simplest method of lubricating the bearings is by means of compression grease cups, which are dust proof and very economical. They are screwed into the ends of hollow shafts, and a man, without stopping, can give the handles a turn as he walks along the belt, and this only has to be done once a day at most. Grease costing about four cents a pound is generally used.

Some of the purposes for which conveying-belts are used are the carrying of trap rock and limestone in stone-crushing plants, charcoal and ashes in sugar refineries, ore in concentrating plants and mines, earth and stone in large excavations, blocks and logs of wood in pulp mills, clay in brick yards, coal in breaker yards, large power plants and culm piles, tobacco in process of manufacture, customers' packages in large retail stores, grain in elevators and flour mills, boxed goods in coffee mills, phosphate ore in the Southern mines and chemical fertilizer in plants all over the country. These are only a part of their uses, but the list of other purposes for which, though not employed, they are equally suited, and must some day be applied, would be a very much longer one.

Belts generally cost less to install than any link belt or other metal conveyer; and the cost of maintenance

Fig. 13.



METHOD OF JOINING THE ENDS OF CONVEYING-BELTS.

is so much less that there is simply no comparison between them. In addition to this, they run noiselessly, instead of making a perpetual and deafening racket, and no owner's ears can become oblivious to a banging and crashing of which every vibration means wear and depreciation, as well as loss of power.

You may say, "If this belt method of conveying is all that this man claims, why haven't we heard more about it? Why isn't it used more widely?" My answer is this: The various systems of sprocket chain, metal pan, trough and screw conveyers and the overhead cable systems have all been owned by manufacturing concerns who make them known by advertising, undertake their construction and installation, and guarantee them. As to conveying-belts, no fundamental patent on the principle could be secured; and because a belt conveyer is composed of two parts, which are about equal in value and the products of entirely separate kinds of manufacture (I refer to, first, the iron pulleys and other supporting parts, and, second, to the belt itself), no iron man felt like pushing the sale of a conveyer when he knew that some rubber manufacturer would share equally in the profits, and the rubber man would doubtless have felt the same if, with his less extensive knowledge of machinery, the thought ever occurred to him at all. And so, between them, the belt conveyer has been neglected except where its merit compelled the recognition of a few wideawake and self-reliant engineers. It has been the property of no one. Nobody's living depended upon its exploitation. It was to the interest of no one to stand sponsor for it; to develop, push it and perfect it. There are no data published about it, and each man who uses it to-day is practically the inventor of his own apparatus, which he has brought to its present state only after an expensive and vexatious experience. If an engineer to-day has a conveying problem to solve and the thought of a belt occurs to him, immediately after come the questions: What kind of a belt? What width? How should it be run? On what? At what speed? Where can I find out? Being unable to answer any of these questions, and not caring to try experiments, his natural inclination is to state his needs to the well-known manufacturers of conveying apparatus and make a contract with one of them, thereby shifting the responsibility as soon as possible. The load of responsibility is apparently charged for along with the apparatus, but even the high price of the latter contains no suggestion of the great and continued expense incurred in running and keeping it in order.

I do not wish to appear as condemning universally the use of all metal conveyers, for there are, indeed, some conditions for which they are better suited than are belt conveyers. I may mention, for instance, places where the point of delivery must be constantly and quickly changed. With iron conveyers this is accomplished by the removal of a section of the iron trough, while a belt requires a movable framework containing two pulleys. This dumping apparatus can be moved to any point in the belt's length, but it is neither as cheap in construction nor as quick in operation as the plan adopted with metal conveyers.

Nor do I condemn the great ingenuity which has made possible even the poor performance, by metal conveyers, of duties for which, by their very nature, they are unfitted. That is business. I only want to show that there are many places where other conveyers are now used for which belts could be substituted with economy.

SELECTED FORMULÆ.

EFFERVESCENT CAFFEINE CITRATE.

Caffeine citrate	20 gr.
Sodium bicarbonate	600 "
Citric acid	300 "
Tartaric acid	240 "
Sugar, powdered	620 "

EFFERVESCENT CAFFEINE CITRATE AND PHENACETIN.

Caffeine citrate	20 gr.
Phenacetin	100 "
Sodium bicarbonate	600 "
Citric acid	300 "
Tartaric acid	240 "
Sugar, powdered	620 "

EFFERVESCENT POTASSIUM BROMIDE.

Potassium bromide	½ tr. oz.
Sodium bicarbonate	3¾ "
Tartaric acid	1¼ "
Citric acid	2 "

EFFERVESCENT CAFFEINE CITRATE AND POTASSIUM BROMIDE.

Caffeine citrate	50 gr.
Potassium bromide	240 "
Sodium bicarbonate	3¾ tr. oz.
Tartaric acid	1¼ "
Citric acid	2 "

EFFERVESCENT MAGNESIUM SULPHATE.

Magnesium sulphate, dried	400 gr.
Tartaric acid	300 "
Citric acid	240 "
Sugar, powdered	460 "
Sodium bicarbonate	600 "

This is practically identical with the granular effervescent magnesium citrate on the market.

EFFERVESCENT VICHY SALT.

Potassium bicarbonate	45 gr.
Sodium chloride	90 "
Magnesium sulphate	45 "
Sodium bicarbonate	5 tr. oz.
Tartaric acid	1¼ "
Citric acid	2 "

EFFERVESCENT PEPSIN.

Pure powdered pepsin	50 gr.
Citric acid	1¾ tr. oz.
Tartaric acid	1½ "
Sugar, powdered	½ "
Sodium bicarbonate	3¾ "

EFFERVESCENT PEPSIN AND BISMUTH.

Pure pepsin, powdered	50 gr.
Bismuth and ammonium citrate	50 "
Citric acid	1¾ tr. oz.
Tartaric acid	1½ "
Sugar, powdered	½ "
Sodium bicarbonate	3¾ "

Library Paste.—A good white library paste may be made by any of the following processes:

1. Water ..... 1 qt.
   Alum ..... ¾ oz.

Dissolve and add enough flour to bring to the consistence of cream, and then bring it to a boil, stirring all the time.

2. Starch ..... 2 dr.
   Sugar ..... 1 oz.
   Acacia ..... 2 dr.
   Water ..... sufficient.

Dissolve the gum, add the sugar, and boil until the starch is cooked.

3. Rich starch ..... 1 oz.
   Gelatin ..... 3 dr.
   Water ..... ½ pt.

Heat with constant stirring, until the milky liquid becomes thick and glassy, when the paste is ready for use.

Any of these pastes may be preserved by adding a little oil of cloves, or carbolic acid, salicylic acid or formaldehyd.—Merck's Report.

The Manufacture of Vanilla Extract.—The compound essence of vanillin of the National Formulary furnishes an article which finds great favor with all who have used it, and it is, perhaps, the most satisfactory of all the preparations of this class which provides for the use of synthetic vanillin. The National Druggist, of St. Louis, recently published the following formulas for preparing three grades of vanilla essences, translated from the Zeitschrift fur Kohlensaure Industrie:

I.

Vanillin	20 parts.
Absolute alcohol	600 "
Water	450 "

Dissolve the vanillin in the alcohol and add the water.

II.

Musk	1 parts.
Potassium carbonate	1 "
Vanilla beans	60 "
Boiling water	240 "
Alcohol	720 "

Mix the vanilla, cut fine, the musk and potassium salt, and pour over them the boiling water. Let them stand until quite cold, then add the alcohol and set aside for 14 days. Finally strain, express and filter the percolate.

III.

Vanilla in fine bits	250 parts.
Alcohol	2500 "
Water	1500 "

Mix the alcohol and water and pour one-third of the mixture over the cut beans. Put into a vessel with a tight cover, place in the water bath and keep for one hour at 60° C. Pour off the liquid and set aside. To the residue in the vessel add one-half of the remaining alcohol and water, and treat in the same manner. Repeat the operation with the remainder of the liquid. Remove the vanilla to an extraction apparatus, pack and extract with 250 parts of alcohol and water mixed in the proportion indicated above. Mix the results of the three infusions, filter, and wash the filter with the result of the percolation, allowing the percolate to run through and mingle with the original filtrate.

To prepare a sirup with either of these essences, mix 15 parts of the essence, 8 parts of caramel solution, and 4,500 parts of the sirup, in which 15 parts of gelatin have been previously dissolved by the aid of gentle heat.

ENGINEERING NOTES.

The finest wire in the United States is said to be made at Taunton, Mass. This metal is exactly $\frac{1}{10}$ part of an inch in thickness—much finer than human hair. Ordinary wire, even although of small diameter, is drawn through holes in steel plates, but, on account of the wear, such plates cannot be used in making the hair wire. The Taunton factory uses drilled diamonds for that purpose.

Some careful experiments which have been made in England prove that the life of a locomotive is about 500,000 train miles. In other words, that a locomotive of the latest approved pattern will run 500,000 miles before wearing out so as to be useless. In making this run of a half million miles the firebox will have to be renewed three times, the wheel tires five or six times, and the crank axles from three to five times.

A street car with pivoted seats is being tried on the Grand Street and Desbrosses Street line in New York City. There are ten chairs on each side, facing toward the front of the car, the seats being supported on brackets. This enables seated passengers to avoid having their feet stepped on by those who are standing on or walking through the car. The seats are reversed at each end of the route by means of a lever. The car was built at the shops of the Dry Dock and East Broadway Railway Company.

Some time ago the French military authorities discovered that the water pipes to a certain citadel were badly furred, their inside diameter being reduced from 2¾ to 1½ inches. After removing the pipes an attempt was made to clean them by immersion in a bath of hydrochloric acid, but without success. It was then decided to try the effect of heating the pipes. To this end they were stacked loosely in a pile and a wood fire lighted around them. After cooling it was found that the furring could easily be knocked out, and of 137 lengths of piping only six were injured in the process.

The Belgian Legation at Athens has issued an interesting report on the draining of Lake Copais. The total surface drained is about 24,000 hectares (hectare = 2·47 acres), of which 7,000 hectares are already cultivated by the peasants of the surrounding villages, 2,500 hectares are provisionally occupied by proprietors of the neighborhood, 400 hectares serve for experiments in cultivation, and form the basis of a large model farm which the Lake Copais Company is creating, and the rest—over 14,000 hectares—is partly covered with reeds and partly serves as pasture. The report also treats of the conditions of leasing the land, the results of the experimental cultivations, the salubrity of the district, etc.

Many railway companies in the East are considering the advisability of organizing a hospital service for their employes according to a system which has been in vogue in the West for several years. The Atchison, Topeka & Santa Fe Company furnishes the hospitals at various towns along the line of the road. But the Plant system has fitted up several hospital cars, which are scattered along the road at division points. In case of an accident, one of these cars is dispatched to the scene at once, and the wounded are cared for properly and immediately. An operating room in the car is fitted with a glass topped table and all the appliances for performing aseptic operations. There is a consultation room, and a larger apartment, fitted with cots and hammocks, in which the injured may be conveyed safely and comfortably to the railway hospitals. It is proposed to have these hospital cars so located that one can be sent to any point on the road within two hours.

Emanuel Stauber, of Hamburg, says the Practical Engineer, who attributes the spontaneous combustion of coal on board ship to the combined effect of the admixture of air and moisture with the gas exhaled by the coal and heat generated by the internal friction of the heaps from the rolling of the vessel, has patented in Germany a system of ventilation, having the threefold object of drying the coal, removing the evolved gases, and preventing the mass from shifting. He proposes to have the floor of the hold perforated, and to set up a pair of longitudinal perforated partition walls down to the center, forming a T shaped air space. This is connected with a double ventilating cowl on deck, the upeast delivering to leeward and the intake facing the wind. In addition to the partition walls, a number of perforated pipes run from the central shaft transversely through the coal at different heights, and fold on hinges when the hold is being loaded or discharged.

Compressed gas for lighting railway cars is to be carried in 2 in. pipes through the streets of Washington, D. C., to connect the works of the Pintsch Compressing Company with the stations of the Baltimore & Ohio Railroad, Baltimore & Potomac Railroad, and Southern Railway, and also to the river front, where it will be used for charging illuminated buoys for the Potomac River navigation. In reporting the bill, Senator McMillan, of the Committee on the District of Columbia, alluded to the project as follows: "Pintsch gas is used for lighting railway cars and buoys. The object to be gained is the lighting of the railway mail cars starting from Washington, thus doing away with the oil lamps, so dangerous in railway mail cars especially; also the furnishing of gas for lighted buoys on the Potomac. The Pintsch gas is in use all over the country, and there is no experiment in the matter. Indeed, the bill simply provides for a commercial necessity."

A series of comparative tests of Portland cement made by American, English, German, Belgian, and Danish manufacturers, published by Engineering News, shows that no nation has a monopoly of the manufacture of good Portland cement; on the contrary, the reputable brands of cement appear to be of about the same quality in one country as in another. This is, after all, what should be expected. Portland cement is made from certain well known constituents, and if those are combined in proper proportions and the process of manufacture is correctly conducted, the product should be about the same, no matter where the manufacture is carried on. There has been, and still is, a large amount of superstition concerning cement among engineers; and we even now hear it said that this or that or the other country is the only one that can produce genuine Portland cement. The diagrams published by our contemporary appear to show how little foundation there is for such statement and the "fallacy of the still too common impression that American Portland cements are inferior to those of foreign countries."

ELECTRICAL NOTES.

Long distance telephones have been placed in the smallest Swiss villages, making it possible to communicate from one end to the other of the country on instruments kept in perfect repair, and on which one can hear distinctly. The fee varies from two to eight cents a message. Electric lighting from water power has been introduced in even small places.

"Queen Victoria, it is stated," says Electricity, "has permitted the installation of the telephone at Windsor Castle, Osborne House, Balmoral and Buckingham Palace. The Pope also favors the telephone, and has had it installed in the Vatican. It is stated that he has gone so far as to permit confessions by telephone, but priests are forbidden to grant absolution by telephone."

The total length of electric tramways in operation in Europe at the beginning of the present year was 902 kilom. = 560 miles, stocked with 1,747 cars, against 700 kilom. = 435 miles and 1,236 cars at the beginning of 1895. Of the above length Great Britain only possesses 109 kilom. = 67 miles, while Germany has 406 kilom. = 252 miles, and France 132 kilom. = 82 miles. The trolley system is adopted on nine lines, as compared with three with underground conductor and eight with accumulators.

"A magnet whose poles adapt themselves to the irregular surface of a piece of iron to be lifted has been recently invented," says Popular Science News. "It consists of a bar of iron, around which are a number of iron rings or collars fitting it closely, between which are placed the coils encircling the iron bar, the current being such as to make alternate poles of the successive rings. The bar is lifted horizontally, and in the lower part of each of the rings there is a short, thick, iron cylinder which has a limited vertical movement; these iron cylinders will project more or less beyond the lower edge of the rings, so as to adapt themselves to an irregular surface of a piece to be lifted."

The recent electrical exposition in New York City, and the tendency of all the visitors there to speak of electricity as still in its infancy, has stirred up some of those who have spent a lifetime in the field to collate statistics with the purpose of showing the absurdity of such an idea. It appears that there are not less than 65,000,000 telegraph messages sent in the United States every year. The number of telephonic conversations is 750,000,000. There are 2,700 central electric light stations and 7,000 isolated electric light plants in buildings of all kinds. These operate about 1,000,000 arc lights and 15,000,000 incandescents, as well as several hundred thousand electric motors. The electric railways of this country reach 1,000, with 12,000 miles of track and 25,000 cars. It is estimated that directly and indirectly some 2,500,000 persons are interested in electricity as their livelihood and sustenance. Such figures, it is asserted, with some indignation, are hardly those of an infantile industry.

At a recent meeting of the Berlin Physical Society, say The Engineer, Dr. Du Bois spoke on the magnetizing and hysteresis of various kinds of steel and iron, basing his remarks on experiments made in conjunction with Mr. E. T. Jones. The discrimination of different samples of iron by means of their hardness has now lost all its importance; the real criterion is rather hysteresis, coercitive power, residual and maximal magnetization, which had been determined, together with other magnetic properties, for a large series of samples. Chemical composition is of less importance than the mode of treatment during manufacture from ore to metal. The magnetic constants of the material are of importance to physicists and technologists. The speaker then gave the results of his measurements for three kinds of iron with maximal and three with minimal hysteresis. As a general rule hardening increases hysteresis and coercitive intensity, whereas residual magnetism is lessened. Krupp's cast iron is distinguished by its low hysteresis and small coercitive intensity.

New York City may not be able to accomplish its wish of securing an underground electric road, but Budapest, in the far east of Europe, is more fortunate. Its object is to unite the belt tramways with the center of the city that they encircle. The current is taken from an overhead conductor placed on the roof of the tunnel, and contact is made by means of cast iron shoes, instead of the little wheel seen on the top of the trolley poles. The tunnels and stations are lined with glazed tiles, and as there is no smoke or dirt, the brightness of the passage is likely to remain untarnished for many years to come. The line is double track, and a speed of twenty miles an hour will be made. It is interesting to note that while the motormen can cut the motors in and out of operation, they cannot regulate the speed, which is done for them automatically. The device is such that it will fix the distance in which the car will attain its maximum speed. The cars are very handsome, and the interiors are said to look like the saloon of a yacht. There are twenty-nine seats, and a great novelty, so far as European cars are concerned, is the fact that there will be room for fifteen people more to stand up.

A communication to an English paper, giving an account of the practical working of the electric welding process in a shop doing a wide variety of machine forging and repairing, says: "We find the electric welding very useful in cases of breakdown. Not long ago we had a two inch countershaft broken, and it caused about 20 hands to cease work until it was made right again. We took the shaft down, stripped the pulleys from it, pieced it up again in one of our welders, and had the men working again in less than 30 minutes. One advantage this system has over the ordinary smith's welding is that there is no waste of metal. We can take two pieces of, say, 1½ inch round (iron or steel), saw them each exactly 12 inches long, and when they are welded together and swaged to size they are just 24 inches long. If a steam engine connecting rod broke we could piece it up exactly the length (without the usual way of making two piecings) and keep it up to the diameter. It would need very little labor in polishing it up again, as every piecing only blackens it about one inch on either side of the weld. We have riveted together boiler plates and similar jobs by placing the cold rivet in position, applying the current to it, and, when sufficiently heated, riveting it up in the usual way."

MISCELLANEOUS NOTES.

Italy has probably the finest collection of anthropometrical statistics in the world, minute details of 300,000 men during their army service having been collected and preserved. The generalized results of an examination of these statistics for the men born during the years 1859–63 have just been published by the War Office.

Gulleries are becoming fashionable in England, large tracts of land in suitable spots being abandoned to the birds, on which they may build their nests. If it is true that gulls' eggs can by coloring and chemicals be palmed off on the public for plovers' eggs, it is possible that the birds may be protected for commercial reasons as well.

Switzerland had in 1894 7,637 hotels, in which $102,000,000 was invested, giving a return of 7¼ per cent. Of the travelers who frequent them, 30·7 are German, 20·7 British, 18·9 Swiss, and only 6·6 American. The hotels employ 26,810 servants, whose wages are $1,500,000, or about $56 a year apiece, the chief portion of their pay coming from tips.

A new soporific, to which the name pellotin has been given, has been discovered in a Mexican cactus called anhalonium. The native Mexicans eat slices of the plant, which they call "pellote." Its hypnotic alkaloid has been separated by Dr. Hefter, of Leipzig. One grain of pellotin is equal in its effects to 15½ grains of trional and to 31 grains of hydrate of chloral. It is effective in quieting delirium tremens only in large doses.

Statistics just issued show that the quantity of gold entered for exportation through the New Zealand customs for the year ending March 31 last was 222,981 oz., representing a value of £889,545; while the quantity for the same period of the previous year was 240,702 oz., valued at £970,220. Although this shows a decrease of 17,721 oz., it should be stated that there is a certain quantity of gold manufactured into jewelry in the colony.

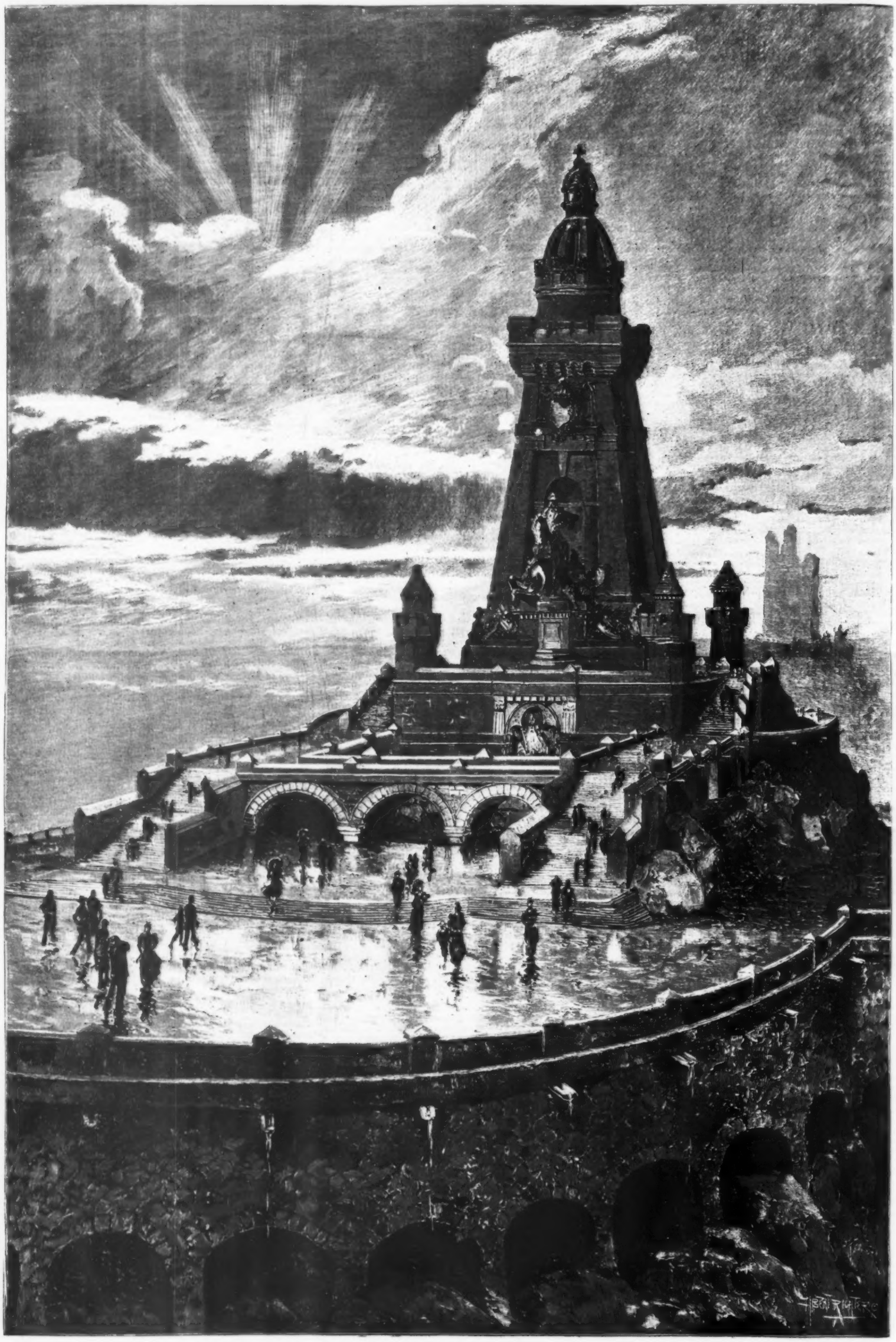
Passengers by the night mail and express trains of the Caledonian Railway, between Scotland and England, may now obtain some measure of rest and comfort on the journey without taking a sleeping berth, by hiring pillows for a fee of 6d. These are issued at certain stations in Scotland, and, when hired, are entered on a special way bill, which the guard delivers to the person deputed for collection at destination. The pillow slips are washed after each journey.

The hot caves of Monsummano, Italy, long neglected, are beginning to receive attention again as health resorts. They were discovered in 1849 by quarrymen, and were found to be helpful to those of the men who had suffered from rheumatism. They were visited by Garibaldi and Kossuth for relief from troubles under which they were suffering. They are hollowed in a porous rock, and an air saturated with moisture circulates freely in them at a temperature of about 88° F. The patient who enters them clad in light robes soon perspires very freely, and may continue to do so during his whole sojourn of from half an hour to several hours.

Lepers are not so uncommon in Europe as is generally thought. One was picked up in the Paris streets recently and sent to the St. Louis Hospital, where there were already six other patients with the same disease. There are isolated cases dotted all over France, while the lepers' hospitals at San Remo and in Spain and Portugal are never without patients. They are gaining ground in Turkey and the Ionian Islands. Crete has 500 of them. They are most numerous, however, in Norway, where there are 800, and are rapidly increasing in Sweden, which has already 462. In British India there are 100,000 lepers. The disease infests Indo-China, Tonquin, China, and Japan, as well as Hayti, Trinidad, Guinea, Venezuela, Brazil, and Paraguay.

It has been practically decided that the whole of the French military artillery shall be remodeled, and the army gradually supplied at a very heavy cost with cannon of a new pattern. Now it transpires that for some time past the expediency of substituting another weapon for the Lebel rifle has been under consideration at the War Office. The choice of the authorities is expected to fall on a rifle of the caliber of 6½ millimeters, of which, it is affirmed, 3,000,000 samples could be supplied at an expense of about £5,000,000. This, however, remains to be seen. So much store has been set by French experts on the Lebel arm that the War Office authorities may well hesitate ere they decide on replacing it, the more so as the modification of the artillery will entail an extremely heavy outlay on the part of the already overburdened taxpayer.—Paris Correspondence London Telegraph.

As a preliminary experiment in coloring flowers Dr. Russell has tested the power of the soil to retain the various salts proposed to be used in the case of white pelargoniums. He took two glass tubes, a foot in length, and three-quarters of an inch in diameter, and drawn out at one end. These were filled with soil from a garden, the amount being 8½ cubic inches. He poured in a solution of sulphate of copper (13 grains to the pint, or quarter of an ounce to a gallon). The water which came through was tested; but 4½ pints passed through before any sulphate appeared, and that only after one month; 56 grains were held by the soil. Similarly with sulphate of iron; 3½ pints of the solution passed through before any iron was present in the water. This took twenty-eight days, so that 47 grains were held by the soil. As an additional experiment, some of the same soil was saturated by shaking it with water; it was then put into a tube similar to the previous ones, and sulphate of copper (13 grains to a pint) poured on as before; 2¾ pints passed through before any copper was traceable. This took fifteen days, 36 grains were held by the soil. The next experiment was made with ammonium salts. Ammonium nitrate was poured on the soil (13 grains to a pint); 4 oz. came through before the ammonium salt was found. The soil thus retained 2¾ grains. This took only three-quarters of an hour. Ammonium chloride.—With this salt, 5 oz. passed through before ammonia was detected, therefore, the soil held 3½ grains. It ran through in half an hour. The significance of these experiments showed that unless the salt be placed directly in contact with the roots, it might be retained in the soil, and no result would follow.—Gardeners' Magazine.



THE EMPEROR WILLIAM MONUMENT ON THE KYFFHAUSER.—Drawn by Albert Richter.

MONUMENT ERECTED ON THE KYFFHAUSER IN HONOR OF EMPEROR WILLIAM.

IT is often very difficult to give proper expression to poetic thought with existing artistic possibilities, and when erecting monuments on commanding sites, the difficulty of securing harmony between the work of man and the impressive majesty of nature is easily underestimated, and therefore a double victory is won when these requirements are so well fulfilled as they are in the monument on the Kyffhauser, which was unveiled June 18. This was designed by Bruno Schmitz, who was assisted in the execution of his plans by the sculptors Emil Hundrieser and Nikolaus Geiger, and was dedicated to the victorious commander in the war with France, the first sovereign of the new empire, by the German veterans.

FIGURE OF EMPEROR FREDERICK ON THE EMPEROR WILLIAM MONUMENT AT KYFFHAUSER.—MODELED BY PROF. N. GEIGER.

It would have been difficult to find a place richer in associations than that chosen. Lying in the heart of Germany, and rising to a considerable elevation, it commands a most extensive view, and whether the eye is turned to the north, on the Harz Mountains, or to the south, upon the Thuringian Mountains, backward or forward, to the right or the left, it meets reminders of the first empire. The traveler has already been reminded that this is historical ground by the roads leading to the spot, especially by that leading from Kelbra, from which he had a view of the ruins of the Rothenburg, a relic of the times of the Hohenstaufens. But on the Kyffhauser itself, on which the Barbarossa Tower still stands among the widely scattered fragments of one of the finest mountain castles of the German Emperor, we seem to see again the form of the great Hauenstaufen, who, in the thoughts of the people, will always be immortal. He and Emperor William stand together before the observer of to-day like waiting desire and successful fulfillment. This imaginary connection between the old and new empires has been given artistic and poetic expression in the Schmitz monument, the greatest charm of which is its simple architectural lines, for it will, of course, be understood that the sculptor must take second place in such a piece of work, placed at such an elevation. The wide scope of Schmitz's plans met with general approbation, they were accepted in the summer of 1890, and work on the monument was begun at once. The main features of the design were carried out as shown in his first sketches, but it became necessary to make many changes in the details, and the skillful handling of the very difficulties presented by the nature of the ground gave new charms to the composition.

The monument stands on ground which used to be covered by part of the castle, one or two towers and the chapel of which, besides the Barbarossa tower, are still standing. The monument consists of a tower that diminishes toward the top, and is provided with a quadrilateral base and a substructure by means of which it is adapted to the shape of the mountain top. The proud symbol of the new empire rises from the indelible memories of the old, using the long lost imperial crown as its finishing ornament, and this thought is felt throughout the entire composition, especially in its sculptural decorations, which have been wisely restricted to a figure and a group with a few ornaments.

The wide lower terrace, which is semicircular and is edged by a parapet, protects the substructure from the dangers threatened by crumbling of the rocky ground, and rises from its surroundings so as to make it more effective. The roads leading to the monument open upon the terrace at the rear, and at the sides the natural stone forms a support for a second stately terrace and staircases. This terrace surrounds the tower and in front forms a court which is entered through three arches that break the main front. This court is made to represent the lost castle of Emperor Frederick. Only the upper parts of the columns that supported the arch of the portal rise above the ground, and after one has entered the room, which seems to have fallen into ruin, he discovers a round niche in the rear wall, with a decorative framework, in which, as if cut out of the rock, the Hohenstaufen Emperor, in the imperial mantle and crown, is seated on the throne. He is supposed to have just awakened from his long sleep. Looking upon this seems to carry the observer back to the time of the legend, but when he raises his eyes, he is brought again to the time of the new empire. Above the third terrace, which constitutes the real base of the monument, and which is provided at the corners with little towers, there is an equestrian statue of Emperor William, in copper, which stands out from the tower on a rounded pedestal. At his feet are idealized figures, of purely German type, one equipped for war, and symbolizing German power, and the other impersonating History, and holding the wreath of victory. From the right and left of the pedestal a frieze of trophies extends around the tower, while above the head of the emperor a gigantic representation of the imperial eagle, with a shield bearing the Hohenzollern coat of arms, is also arranged like a frieze. A battlemented parapet completes the square tower, from the center of which rises a baldachin, formed of eight strong stone arches that support the regained imperial crown, which forms the summit of the monument.

The above is a description of the exterior of the immense Kyffhauser tower, which was built in five years. The interior of the substructure forms a hall, intended as a memorial hall, and above that the interior is divided into stories, through which a central staircase extends to the top of the tower. A few figures will give an approximate idea of the proportions of the monument. The lowest terrace is 30 ft. high, 426 ft. long and 315 ft. wide; the third terrace is 98 ft. high and the tower extends above it to a height of 187 ft. The tower is 66 ft. square. The equestrian statue measures, from the hoofs of the horse to the top of the helmet, almost 30 ft. The masterful treatment of these masses, required for a monument erected in such a place as that chosen for the Schmitz monument, is most creditable to the architect and those who assisted him, especially to the two sculptors who produced the Emperor William group and the figure of Emperor Frederick. To the latter the artist, Geiger, has succeeded in giving the peculiar and mysterious charm of the legend, while Hundrieser's great power is shown in the sharp and clear lines of the equestrian statue, a truly great work. On account of the simplicity of the treatment of the whole monument, there seems to be no inconsistency in thus bringing together on one monument the emperors of the old and the new empires.—Illustrirte Zeitung.

THE EMPEROR WILLIAM MONUMENT ON THE KYFFHAUSER—EQUESTRIAN STATUE OF THE EMPEROR.—MODELED BY PROF. EMIL HUNDRIESER.

GRÆCO-PHŒNICIAN ARCHITECTURE IN CYPRUS.

THE following is an epitome of a paper read by Dr. Max Ohnefalsch-Richter, before the Royal Institute of British Architects.

The author, in presenting this interesting paper, first gave a description of the three royal tombs discovered by him at Tamassos, in Cyprus. The sepulchers of a Græco-Phœnician type of architecture were, he maintained, of the seventh and sixth centuries B. C. A feature of peculiar interest in these subterranean stone buildings was the direct imitation in stone of constructions of wood, and this in a perfection which had never before been met with in remains of ancient monuments. Wooden columns, windows, locks, bolts, roofs

were all reproduced in stone. He had found their counterparts surviving in modern buildings of Cypriote villages.

The lecturer then proceeded to give his reasons for his conclusion that the Ionic volute was derived from the Egyptian lotus flower design, and that the same origin was traceable in regard to the Greek palmette and anthemoin. The theory which would ascribe the origin of the Ionic volute to the Assyrian sacred palm tree could no longer be maintained. A small clay model of a sanctuary—evidently a votive offering—discovered at Idalion, in Cyprus, some time ago, showed again the two lotus capitals on the columns supporting the porch. Some Hathor capitals discovered in Cyprus demonstrated the fact that Cyprian artists during the Græco-Phœnician period combined Egyptian, Assyrian and Greek elements. On one of the columns was sculptured a design of a complicated lotus tree with winged sphinxes.

Dr. Ohnefalsch-Richter next referred to Herr Koldewey, a German architect who had put forward a new theory, in his book "Neandria," distinguishing between three classes of archaic capitals with curved volutes—the first with crossed lines, the Cyprian; the second, with vertical volutes, called Æolian; and the third, with horizontal volutes, called Ionic. These three he considered to be branches all growing out of the same trunk, which was of old Cappadocian origin and which he declared to be the prototype.

Herr Koldewey denied any connection of the Ionic capital with Egypt or the Egyptian lotus flower. Herr Puchstein, in his book on the Ionic capital, appeared to be of the same way of thinking. The Cappadocian columns of a baldachino from a rock relief which had been put in evidence by the above mentioned authors were extremely simple. The whole volute merely consisted of two spirals connected by a canalis and bent downward. In the upper line of the canalis of this Cappadocian capital Koldewey saw the horizontal tendency of the Ionic volute to be latent. The two spirals touched the vertical line of the shaft of the column, and in this fact Koldewey saw the vertical tendency of the Ionic volute in the same Cappadocian capital.

Dr. Ohnefalsch-Richter, however, had found, during the excavations which he had carried out for the German Emperor, a small votive column even more regular and more simple than the Cappadocian column. The canalis above was horizontal and was covered already by an abacus. The spirals also touched the shaft with their inner and lower parts in a more finished and regular form than in the Cappadocian example. He maintained that the columns from Cappadocia, Cyprus, the oldest archaic Ionic volutes from Uyra, Olympia and other places, were simplifications of much more complicated Græco-Phœnician volutes, which on their part were derived from the Egyptian lotus. A reference to the architectural details of one of the three royal tombs of Tamassos showed how a complicated lotus design was changed into a more simple form, and thus prepared the way for the formation of the Hellenic Ionic volute.

From an interesting series of Græco-Phœnician Cyprian capitals, with palmettes over the volutes, to which Dr. Ohnefalsch-Richter referred, he showed that the three types of capitals classified by Koldewey actually occurred in Cyprus. The Ionic volute, with its beautifully ornamented cymation, which belonged to the archaic temple of Diana, at Ephesus, and which had been lately pieced together by Dr. A. S. Murray from fragments in the British Museum, he fully admitted to be the oldest existing example of a pure Hellenic Greek volute. He referred to Dr. Murray's paper, lately read before the Institute, showing the great importance of the Ephesian capital preserved at the British Museum, especially since its no less valuable twin brother, the well known Samian capital, had disappeared.

As a last illustration, Dr. Ohnefalsch-Richter exhibited a photograph of an Ionic Greek capital now in the Cyprus Museum at Nicosia, and discovered at Larnaca in 1879. In this case there was no ornamental cymation properly speaking. The sole decoration below the lower margin of the canalis and the spiral consisted of two palmettes or lotus flowers growing out of the corners. The upper and lower margins of the canalis were not straight, but considerably concave, and both lines ran parallel to each other. The proportions of the capital were very harmonious and Greek, but it was difficult to date it. The concavity of the lines of the canalis seemed to point to a later date than the archaic Ephesian volute of the Artemisium.

Professor Aitchison remarked that every one who had begun his architectural studies with the classic must have taken the most profound interest in the Ionic order, and probably made theories of his own as to how it originated. He must confess that his own theories on the subject appeared to have been far from the truth, for he had always supposed that the Greeks, being a maritime people, and living mostly on the seashore and on islands, must have taken their idea of the Ionic capital from the univalve shells, which they saw so plentifully about them. However, it seemed that the origin of the Ionic capital was not an animal, but a vegetable one.

The forget-me-not buds and opening ferns were striking illustrations of the plant spirals. Doubtless these discoveries lately made at Cyprus gave an overwhelming probability, even a possible proof, that the first idea of the Ionic capital came from the lotus. It would be interesting to have some examples of the spirals which the lotus flower formed. Like many theories, one could not at present carry it further, though when once suggested it carried an irresistible conviction to the mind. The canalis of the Ionic capital must, he thought, have been suggested by some of the shells they saw, but that would not affect the origin of it being from a plant, probably from the lotus.

Dr. Richter pointed out how wonderfully similar an example on his second sheet was to the celebrated internal capital of the Temple of Apollo at Bassæ. The way in which the abacus of this capital had been managed was one of the great marvels of the skill of the Greeks, almost everything they touched exhibiting the extraordinary qualities with which that great people were endowed. Dr. Richter had referred to mortar as being used in these graves at Cyprus. He (the speaker) when he went to Egypt was under the conviction that the Egyptians had not used mortar, but when he visited the great Pyramid of Gizeh he found every stone had mortar joints. In the chamber of the king and of the queen every joint of the great slabs which formed the roof was filled with mortar. He brought home specimens of this mortar, and, on having it analyzed, found that the exterior mortar was composed mainly of lime and sand, while the interior mortar, although containing lime, was principally composed of plaster of Paris. The joints which had misled so many of the antiquaries into the belief that they were like the Greek joints, dry, were simply a device to give a more elegant appearance to the masonry, while within the joints there was a channel on both stones, so that the mortar acted as a continuous tie between them. He unfortunately had no acquaintance with Egyptian dates, but if, as he presumed, the Pyramids of Gizeh were very much older than 600 B. C., it was not surprising that mortar was found at Cyprus.

$250 PRIZE ESSAY COMPETITION—PROGRESS OF INVENTION DURING THE PAST FIFTY YEARS.

1846 HAS AN HOUR'S CHAT WITH 1896.

Second Prize, won by ("LIBERTY") EDMUND BECKER, Washington, D. C.

Dramatis Personæ.

Vigorous Old Gentleman, reading a newspaper.

Young Civil Engineer, notebook in his hand, sketching and figuring.

Place: Fifth Avenue Hotel, a quiet nook near a window.

Old Gentleman—Excuse me, my young friend, are you not an engineer?

Young Engineer—I am practicing in this city since '94, when I graduated from the Rensselaer Institute.

O. G.—Indeed! Why, I am of the class of '44. We are chums. Shake! Fifty years separate us, during which I have been secluded from all contact with civilization. Desirous of emulating Darwin, I sailed in 1846 from New York on a clipper bound for Australia; our vessel foundered in the Pacific Ocean. Eight days on a raft drifted us toward an unknown islet, where we spent forty-nine years of the most uneventful life, until rescued by a New York trading schooner. I arrived here on the twentieth of June, and in the last ten days have been so amazed that I begin to lose my bearings—those bearings which in my time were considered sufficient to guide a man through life. I am happy to have met with a friend who will not make fun of the ignorance of a man of threescore and fifteen. But it would, I fear, take too much of your time to bring me up to date.

Y. E.—Not at all; I am quite at your disposal. First of all, what were in your day the great fundamental discoveries of our century?

O. G.—Davy's arc and electrolysis, Oersted and Ampere's electro-dynamics, Daguerre's photography, Henry and Faraday's induction, and Joule's mechanical equivalent of heat.

Y. E.—Well, since then we have had Helmholtz's conservation of energy, Kirchhoff and Bunsen's spectrum analysis, Pasteur's germ theory, and Roentgen's rays. You see that you have very little to learn; but let me remark that B. Thompson, better known as Count Rumford, had anticipated your Joule some fifty years.

O. G.—I have been coached in the germ theory by an old friend, a physician, and have attended a lecture on Roentgen's rays. The lecturer took great pains to show that all these things were known long ago.

Y. E.—It often happens that after a great discovery many precedents are found. Photography has always been done by the sun, spectrum analysis was in embryo in Fraunhofer's lines, and the germ theory in ancient poems; but the true discoverer is the one who puts the whole problem solved in our hands.

Our progress is chiefly the resultant of the co-operation of forces which before our time were operating singly.

Your mechanic made fine and clever work, but ours makes the tool which will allow any one to do the same better and quicker. The tool is the triumph of our time. I could show you a revolver retailed at sixty cents, a better arm, stronger and more reliable, than the expensive Colt, which was part of your traveling outfit.

America needed work and lacked hands; hence the tool. Her immense area made rapid means of communication a necessity; hence the extraordinary development of her steam navigation, her railroads, her telegraphs and telephones. Statistics show that, of all existing means of communication and traffic, we possess a good half.

O. G.—I have been told that the whole world is now pretty much on a level in the matter of progress, but, being an American, I have a special interest in learning what our country has done in the past fifty years.

Y. E.—When you left, Howe's sewing machine was one year old.

O. G.—Yes. I remember having seen one. Everybody wondered at that needle with the eye near the point.

Y. E.—The sewing machine is now doing three times as much work as could be done by hand, were every human being to sew ten hours a day. Our shoes are now sewn by machinery; the shoemaker is nearly extinct. A shoe is made by a team of some twenty men and women with as many machines.

O. G.—What became of Goodyear's patent of 1844?

Y. E.—Vulcanization has made the use of rubber so general that it has become exceedingly valuable. The recent partition of Africa between the European powers is based chiefly on new fields for the production of rubber and gutta percha.

O. G.—Gutta percha in my time was only an object of curiosity.

Y. E.—Millions of tons of gutta percha lie at the bottom of the sea in telegraphic cables. Gutta percha is the best solid insulator known. When metalized to render it conductive, it is also much used in electrotypy, because of its plasticity in hot water.

O. G.—What has been done here in steam engines?

Y. E.—Corliss patented his engine in 1849; the Corliss is known and built the world over. We have also successfully manufactured high speed engines, the highest speeds being attained by the Laval steam turbines. Steam is now worked expansively: the compound engine has two cylinders; three cylinder or triple expansion engines are the last thing out. But it is in the inventions connected with the locomotive that the American genius has stamped its peculiar character. The American locomotive is the type which leads the world. Our four wheeled truck is being introduced everywhere. Eighty tons of weight and steam at two hundred pounds pressure is our common present practice.

O. G.—Oliver Evans, in 1795, used high pressure steam.

Y. E.—Yes; but Watt eclipsed the American genius—Watt was English, you know.

We have been foremost also in boilers of all systems; the Babcock & Wilcox boilers are widely used in Europe.

Pumping engines for water and air are built here on an immense scale; the pipe lines, which convey petroleum for hundreds of miles to the seaboard, and our numerous water works, have required the most powerful and improved engines.

O. G.—I passed yesterday a few hours in the Herald building; the contrast between the Herald establishment of 1846 (which I knew well, my father being a proof reader there) and the Herald of 1896 shows the immense progress made. An obliging employe told me that these magnificent web cylinder presses were introduced in 1853 and improved by Applegath in London, Marinoni in Paris, and Hoe in New York. But the typesetting machinery struck me as the great novelty there.

Y. E.—Yes; and these machines excel in what was considered impossible—they justify automatically.

O. G.—One of the great features of the modern printing establishment is stereotyping, by which the prototype is never used.

Y. E.—To-day the original engraving, artistic or mechanical, is seldom used directly.

O. G.—What have the electrical machines of to-day, which you call dynamos, in common with the attempts of Pixii, in 1833, and Faraday's copper disk, rotating between the poles of an electro-magnet?

Y. E.—The crude experiments of Pixii became later the Clarke magneto-electrical machine; Wilde replaced the steel magnets by electro-magnets, Siemens created the dynamo by exalting the residual magnetism of the electro-magnets, Gramme came in 1870. Then our great American inventors, Brush, Edison, and Thomson, entered the field, and contributed largely toward a final success.

Dynamos have since been made to give alternating currents, and the polyphase system promises great results. The dynamo is the machine of the future, and rightly did Chauncey Depew say, May 16 last: "God creates, nature treasures, science utilizes electric power for the grandeur of nations and the peace of the world." Faraday's discoveries on induction were applied in 1851 by Ruhmkorff, in his coil, and later by Goulard and Gibbs, in their transformers, by which a current of low voltage can be made a current of high voltage. Elihu Thomson, reversing the process in 1886, invented the art of electric welding.

O. G.—Well could Faraday exclaim, "What's the use of a baby?" when asked about the utility of his experiment. I recognize Davy's arc in the arc light, but the incandescent light was quite unknown to me.

Y. E.—Edison, in 1878, devised a lamp consisting of a platinum spiral wire, which was replaced later by carbon. The incandescent lamp, which is now good for 600 hours, is sold for about 30 cents.

O. G.—Davy also, with his battery of 3,000 plates, had shown the prodigious heating power of the electric arc.

Y. E.—Since the cheap production of electricity by the dynamo, the electrolytic experiments of the great English chemist have been turned to account. We have now great works where impure copper, lead, alloys, etc., are turned into chemically pure metals. With carbons of great section and an adequate current, we produce the highest temperatures in the fiercest of furnaces which melts, sublimes, decomposes, and combines the most refractory substances. Potassium, sodium, aluminum, magnesium, are produced at one-twentieth of their former cost. Carbide of calcium has become cheap enough to make it one of our lighting agents: in the presence of water, it is decomposed into lime and acetylene.

Not only have the highest temperatures been attained, but also temperatures far below any previously recorded—more than 200° below zero—thus rendering possible the liquefaction and solidification of all the gases, including even the air we breathe.

O. G.—How marvelous!

Y. E.—Still greater wonders are dawning. Tesla, following in the footsteps of Henry and Faraday, has experimented on currents of thousands of volts, and millions of alternations a minute. His object is to produce phosphorescence, that is, "light without heat," which is the goal of our present physicists. Edison has recently reached results in this direction which are said to reduce the expense of lighting by half.

O. G.—America being one of the granaries of the world, improvements in agricultural machinery must have been great.

Y. E.—Yes; the farm of to-day is a regular machine shop. Foremost among the agricultural inventions stands McCormick's mower and reaper. American agricultural machinery has spread all over the world and is the cause of the low price of cereals. To our farmer is now opposed cheap labor combined with improved implements; hence the decline of the value of our farms.

O. G.—Passing by, I saw many planing mills.

Y. E.—Planing, together with the moulding, tenoning, mortising and hundreds of other American machines, have revolutionized woodworking. The carpenter to-day is simply a fitter and a nailer.

O. G.—I was in a new building and nearly fainted when I saw a carpenter driving screws with a hammer and sending them home with an apologetic final turn of the screwdriver. We used to make a hole with a gimlet. You have put a gimlet point on the screw.

Y. E.—Yes. This is also an American invention, but we have changed all that, and make the drive screw, which is really intended to be driven by the hammer, turning automatically as it receives the blows.

O. G.—Metal working and woodworking machinery appear to have grown apace.

Y. E.—Yes. Had you been at the Chicago Exposition, you would have admired the machines of an American watch factory under the guidance of girls, automati-

cally dropping at short and regular intervals the pieces of a timekeeper. The same is seen in an American arms factory. The war of secession, which stimulated Americans in all directions, required an enormous number of guns and led to the adoption of new methods and tools. The precision then attained realized the dream of Eli Whitney—"interchangeable parts."

O. G.—The telephone and the phonograph, I understand, depend for their operation on the vibrations of sound.

Y. E.—Exactly. To-day everything is vibration. Light, heat, electricity, are all now considered and have been proved to be modes of vibration.

O. G.—Has anything been done in ballooning?

Y. E.—Aeronauts will use balloons until the motor which will propel the Langley and Maxim American flying machines shall have been made. Meanwhile Lilienthal, in Germany, is forming a school of flying pilots who will be ready whenever the motor is found.

O. G.—Have any new substances been found having special industrial value?

Y. E.—Petroleum and natural gas, both American products. Petroleum for thirty years has filled an important place in the world and is displacing the other oils for lighting and lubrication. From coal the tar compounds and the beautiful aniline colors are produced, and synthesis has become the new law of chemistry. The sinking of thousands of oil wells has made the American the best well sinker of the world, be it for petroleum, natural gas, or water.

O. G.—The typewriter is also American.

I have heard that Beach, of the SCIENTIFIC AMERICAN, constructed the first typewriter some twenty-five years ago. The success of the typewriter was assured, because it does away with illegible writing.

Y. E.—But it succeeded mainly because it is more rapid and permits of simultaneous manifolding, making as many as six copies at one writing.

O. G.—What part have Americans taken in the progress of photography?

Y. E.—The Americans Draper, Ives, Carey Lea, have an honored name in the history of photography, but Muybridge is the one best known as opening an entirely new field, the analysis of the most complicated motions by a series of instantaneous photographs. Kurtz and other Americans have succeeded by photographic and purely mechanical processes in producing and multiplying an endless number of pictures bright with all the colors of the original. But photography is now done without the aid of the sun. Photographs are actually made at night by the flash of magnesium. Five or ten cents' worth of magnesium powder accomplish the prodigy.

O. G.—Nowadays everybody seems to be a bicyclist and a photographer.

Y. E.—Osborne is one of the fathers of photo-lithography; all photo processes have been brought here to the highest perfection, to the detriment of American engravers, whose position has become precarious.

O. G.—The magnificence of your illustrations strikes me as wonderful.

Y. E.—Although not American, steel and ice making have here taken an extraordinary expansion. We produce one-half of all the steel and ice manufactured *because* we need more of them than anybody else.

History has always been divided by eras named after conquerors, the beginning of this century being called the Napoleonic era. Little could Bessemer dream that his converting cast iron directly into steel in 1856 would give us the "age of steel."*

O. G.—I have been told that iron is now dearer than steel.

Y. E.—By Harveyizing our nickel steel armor plates we have made the defensive power of our fleet four times greater.

Engineering could not have progressed without reliable testing machines; ours test anything, from a hair to a four inch bar of steel. The knowledge of materials has made easy the building of our great structures, which exceed in magnitude anything before erected. We have the longest suspension bridge at Brooklyn, and we are studying the plans for the longest rigid span—the proposed bridge over the Hudson River.

O. G.—The diversity of modes of transmission of power is remarkable.

Y. E.—Yes. Never has power been put more cheaply and conveniently, so to speak, at your elbow. We have the cable, the electric, and the compressed air systems, but the storage battery is the ignis fatuus in which millions have been sunk. Still I believe its principle will some day lead to great practical results.

O. G.—The electric translation of Niagara Falls to New York seems to me a most brilliant achievement of modern times, and is equal to conversing by telephone between New York and Chicago or seeing a bone through eight inches of wood by means of the Roentgen rays.

Y. E.—This last discovery illustrates clearly the rapidity with which a new idea is now propagated and bears fruit; since January it has been discussed and investigated all over the world. Fifty years ago such a result would have been impossible.

We have also invented the machine which makes steel balls so perfect that they do not vary by one-thousandth of an inch. They are used for the ball bearings of our bicycles.

O. G.—Speaking of bicycles reminds me that we had nothing like them in '46.

Y. E.—The velocipede became popular in 1867; it was followed by the upright machine in 1878; ten years later came the actual bicycle. The velocipede weighed one hundred and twenty pounds, our bicycle twenty-one. The pneumatic tire is a most important feature of the modern machine.

O. G.—Your elevator is our old hoisting engine adapted to persons.

Y. E.—Yes; and it answers so well to our "hurry to get there" that it has made the stairs obsolete. We do not go any more up and down. We are "shot."

O. G.—This is what permits you to make your houses so high and so hideous, too.

Y. E.—Progress is not always æsthetic. But the most useful elevators are tremendous elevators at ports of delivery which handle the crops of our country, the ore and the coal. Their enormous capacity has reduced the cost of handling to a trifle and solved the problem of our Western trade. A grain elevator is at the same time an immense warehouse which cleans, weighs, rates and stores sometimes as much as one and a half millions of bushels in raised bins, from which the vessels or cars are loaded by gravity. An elevator receipt is negotiable in any bank.

O. G.—We had wind, water and steam; also Ericsson's hot air engine. What new powers have you?

Y. E.—We have the explosive engines, all founded on the old electric pistol. But the most important are electricity and compressed air, which permit of easily conveying power to the greatest distances. Your Ericsson, who was also an inventor of the screw propeller, has become famous as the builder of the Monitor, which decided the naval supremacy of the North during the war of secession.

O. G.—You call this epoch the "age of steel." From the impression it has made on me I should call it the "age of light." Our approach to New York by sea at night was a surprise to me. The coast was a continuous line of fire, while the skies over our great city were glowing with the reflection of what could have been taken for a great conflagration.

Y. E.—To call our time an age expresses poorly our wonderful epoch. If we are anything, we are "fin de siecle," that is, unique in present achievements and hopeful of still greater ones. The unexpected has so often happened that we have ceased to wonder and are ready for anything that will turn up. The Roentgen rays are called the X rays, but we shall, perhaps, have Y vibrations and Z effects, and are ready to take the whole alphabet backward for any new surprises. It would take weeks to speak of all that has been done in the last fifty years, but I should like to say a few words of a force nearly unknown in your time, and which is still unnoticed in our books on engineering. It is the co-operation of capital with the other forces.

O. G.—Kingly favor and protection were formerly the only hope of the inventor and the artisan. I remember well that Morse for seven years wearily lobbied Congress before he received thirty thousand dollars for his experimental line from Washington to Baltimore.

Y. E.—Now billions are furnished by public wealth for the building of canals, railroads, telegraph and telephone lines. Our public wealth has increased so much that while fifty years ago every State had its millionaire, every county has one now. Financiering has its laws as exact as those of mechanics. Cool, energetic, courageous, prompt and persevering, the financier requires all the qualities of an engineer or a general. Cyrus W. Field, who started in 1854, failed twice, lost millions, but succeeded in his third attempt, is one of the greatest figures of modern times.

What characterizes our epoch is money. Time is money! Let us have speed—success is money! Let us succeed, and money makes money! Let us work our capital.

O. G.—The richer we are, the better we shall live and the better we shall be. Moral progress grows apace with intellectual, for (Matt. ix. 8) "they marveled and glorified God, which had given such power unto men."

* Bessemer, in 1856, made precisely that prediction.—Editor.

BUSHMEN'S ARROWS.

IN the following description of the method of the manufacture of the arrows, and of obtaining the poison with which the stem is anointed, we shall confine our attention to the customs that obtain in Namaqualand, whence we have received our information, says the Scientific African.

The Bushman arrow consists of a very small triangular iron head fixed in a short piece of reed, about the length of one internode, to which it is tied tightly with thin leather reims, but in such a way that the iron head easily leaves the shaft when one tries to extract the arrow from a wound. This short piece of reed carrying the head fits into the shaft of the arrow like the joints of a fishing rod, and sometimes there is a second joint fitted between the shaft and the head piece. The reason of these joints is that, suppose an animal has received the arrow in his flank, he would naturally turn round his head and try and tear the arrow out. This could be managed in one pull if the head and shaft were solidly joined together, but where he has to pull out first the shaft, and then the little bits of reeds that are joined into one another, even if he eventually manages to get out the iron head, sufficient time will have elapsed for the poison to have got into the blood, and the animal is in that case doomed. There is no record of Bushmen obtaining the iron for the arrow heads from the ore; probably they obtained it from assegais dropped by the other natives, and, from the small size of the heads, it is evident that they had to rigidly economize their little store of metal.

The shaft of the arrow is made out of a jointed reed, a small kind, about four feet high, and growing in swampy places, being generally used; but, as these are rarely straight, they have to undergo treatment before they can be of use. The nodes, or solid joints in the stem, are first broken through, so that one can see right down the middle. The reed is then soaked in the water for several hours; meanwhile a stone is prepared, having a groove on its flat surface deep enough to hold the shaft, and is placed in the embers of a fire till it is moderately hot. The soaked reed is then placed in the groove and covered with warm sand, when, what with the moisture and heat, it becomes so soft and flexible that it can be twisted and turned in all directions. By looking through the hollow shaft, the Bushman is able to see whether the reed is straight or not without removing it from the stone, and he bends it about till it is so. When he has straightened it to his satisfaction the stone with its contents are allowed to cool, and on taking the reed out it is perfectly rigid and not liable to twist again. The short bit of reed containing the head is then fitted to one end, and a single hawk's feather tied to the other, and the arrow is complete.

Many methods of preparing the poison have been described, and according to some the poison is said to be extracted from the root of the plant Buphane toxicaria, or Gift-bol, but it seems that the extract is only used as a resin. The following account we believe to be the true one, at least for Namaqualand. The Bushman obtained some resin, either from the Gift-bol or from one of the members of the Euphorbia group of cactus-like plants, and placed the sticky substance on a stone. He then went with a forked stick to look for the "ring-halse" or black night adder, not the puff adder which we call the ring-halse. Having found the snake, by a dexterous thrust of the stick the animal is imprisoned just behind the head by the two prongs of the stick. The prepared stone is then placed in the mouth and the upper jaw forced right back. By this somewhat rough treatment the poison glands become compressed and two drops of poison forced out on the fangs and caught on the stone. The poison is then well mixed with the resinous matter and is ready for use. In the earlier days a more complicated procedure was adopted through the medium of the witch doctor. The whole head of the puff adder was obtained and put in a pot along with the resin, and beetles and noxious herbs added to the incantation of the witch doctor. The whole was stewed up amid great excitement. The fumes of the brew got into the head of the operator and occasionally the paroxysm of religious enthusiasm ended in the man falling with his head into the pot and being killed. When the contents of the vessel were properly mixed, the sticky compound was collected by stirring it with a stick, to which the matter adhered, and, on becoming cold, remained on the stick as a black knob and formed then an article of barter.

The poison is not placed on the tip of the arrow, but in the portion of the reed that held it, the reason being, probably, the danger to the little archer should he scratch himself with the weapon. In shooting, the Bushman shoots high in the air and lets the arrow strike the quarry from above, because the object of the weapon is not to maim the animal with the force of the blow, but merely to inflict a wound into which the poison can get.

When the Bushman shot an animal, the flesh was carefully cut into long flat strips as broad as they could get them. The first strip was cut, and, without slicing it right off, they cut a second strip beneath it in the reverse direction, and so on till at last they obtained a band of meat several yards long. This was then wound round and round their bodies, where it became dried into a sort of biltong, and also became highly odoriferous and flavored with the perspiration of their skin. But when these disagreeable factors were overcome, the advantage to a people hunted by their larger brethren and liable to surprises at any moment, of having a supply of food always about them, quite outbalanced the æsthetic advantages of having fresh meat.

MAGNETISM AT LOW TEMPERATURES.

SOME interesting investigations on the effect of extremely low temperatures on the magnetic properties of iron and steel have been embodied in a paper by Profs. Dewar and Fleming, which has been read at the Royal Society. Knitting needle steel at various tempers, chromium, aluminum, and nickel steels, pure nickel, silicon steel, and soft and hard iron were experimented with, the samples tried being made up in the form of small needles about 15 mm. (0·6 in.) long and magnetized to saturation. They were brought to temperatures as low as —185 deg. C. by means of liquid air and tested in a reflecting magnetometer. Broadly speaking, the results obtained were:

1. That the sudden cooling to the temperature of liquid air usually permanently decreases the magnetic moment of short magnets made of many varieties of steel, assuming them to have been initially magnetized in a strong field.

2. This initial decrease is found both in hardened steels having great coercive force, and also in the same steels in a soft or annealed condition, and is especially conspicuous in the case of the 19 per cent. nickel steel.

3. In the case of most steels the effect of cooling magnets made of them to —185 deg. C. is to temporarily increase the magnetic moment after the permanent magnetic condition has been reached.

4. The exceptions to the above rule are the nickel steel with percentages of nickel from 19 to 29 per cent., in which case the magnetic moment is always decreased temporarily by cooling to —185 deg. C., after the permanent magnetic condition has been reached.

5. It appears that one of the best ways of ageing a permanent magnet is to dip it several times into liquid air. It then arrives at a constant condition in which subsequent temperature changes have a definite effect, and in which the subpermanent magnetism is removed.

In order to determine if similar changes of magnetic moment could be produced in the case of soft, annealed iron, small magnets of Swedish iron were prepared, formed of a short length, about 15 mm., of soft iron, or a small slip of annealed transformer iron. On magnetizing these in a strong field, and testing them with the magnetometer, and cooling them by immersing in liquid air, it was found that the first effect of the cooling was to produce a small diminution in the magnetic moment, and the subsequent heating in some cases produced a further diminution of magnetic moment. In the first sample of soft iron, the wire was about 3 cm. long, and bent into a U shape, with ends about 10 mm. apart, and in this case the changes of magnetic moment were similar to those in the case of the carbon steels, only with very much narrower limits of variation.

The first cooling hardly produced any change whatever in the magnetic moment of the magnet. On allowing it to heat up again, the magnetic moment was very slightly diminished, and thenceforth the changes of moment were such that the magnetic moment was greater when the magnet was cold than when it was warm, by about 2 or 3 per cent. of the latter value. In the case of a straight soft iron magnet formed of annealed transformer iron, the curious fact was noticed that whereas a rapid cooling of the magnet by plunging into liquid air hardly produced any effect on the magnetic moment after the first initial loss of magnetism had taken place on cooling, the effect of a slow cooling down to the temperature of —185 deg. C. was always to produce a permanent diminution of magnetic moment. Hence the magnetism of this soft iron sample could be frittered away by a process of slow cooling to —185 deg. C., and intermediate heating up to 50 deg. C.

A sample of the same iron, hardened by hammering, was tested, and was found to behave in a very similar manner to the glass hard carbon steel, the changes in magnetic moment being relatively about the same percentage for the same temperature change—that is to say, the magnet had a moment of about 10 per cent. greater at —185 deg. C. than at 5 deg. C. Since a 19 per cent. nickel steel magnet increased in magnetic moment when heated from —185 deg. C. to +5 deg. C.,

and since it is well known that at some higher temperature it would lose its magnetism altogether, it follows that there must be a temperature at which it would have its maximum magnetic moment. After repeated heatings and coolings this temperature was found to be about 56 deg. C.—The English Electrical Engineer.

TWO VETERAN STATESMEN.

ONE of the principal events of Li Hung Chang's brief stay in Germany was his visit to Prince Bismarck. The visit lasted about two hours. Toward three o'clock Prince Bismarck, wearing a cuirassier uniform, appeared outside the castle with Li Hung Chang, whom he afterward conducted to his carriage. The two venerable statesmen shook hands warmly on parting. While in Berlin the Chinese statesman also visited the Charlottenburg Polytechnic, when Prof. Slaby showed a number of experiments with the Roentgen rays. The Chinese envoy consented to an attempt being made to discover, by means of the rays, the position of the bullet fired at his head by the assassin at Shimonosaki last year. The image of the head which was obtained showed clearly the track of the bullet in the left cheek, and the bullet itself lodged in the tissue slightly below. But more than by anything else Li Hung Chang would seem to have been impressed by his inspection of the Krupp Works at Essen. Our illustration is from a photograph by the Neue Photographische Gesellschaft sent by Mr. Arthur Mennell and republished from the London Graphic.

TWO VETERAN STATESMEN—LI HUNG CHANG WITH PRINCE BISMARCK ON THE BALCONY OF THE CASTLE AT FRIEDRICHSRUHE.

PROFESSOR PETRIE'S INSCRIPTION.

THE text of Professor Petrie's new inscription of King Merenptah, B. C. 1200, mentioning "the people of Israel," has been recently given. The following is from Professor Petrie's article on it in the Contemporary Review:

"(a) The first and most obvious view may be that it refers to the oppression of the Israelites in Egypt. As Merenptah is usually thought to be the Pharaoh of the Exodus, whose father commanded the destruction of the male children, Israel being spoiled so that it has no seed might be taken as a reference to this edict. But against this is the placing of the reference between the mention of Yenu (or Yanuh, near Tyre) and the conclusion that Syria is widowed. This strongly shows that the Israel here referred to were already in Syria; and it would be hardly possible that after reciting the Syrian towns, he should turn to a Syrian people in captivity in Egypt, and then conclude with naming Syria as a whole. Yet the chance of this must be balanced against the possibilities of the other views.

"(b) The next view may be that this refers to the twelve tribes in Palestine after the Exodus. Were there any trace of an Egyptian invasion in the Book of Judges, we might readily grant this. But amid all the turmoil with local rulers around, there is no trace in the records of the south, west or north of any Egyptian influence; had the twelve tribes been then in Palestine they would have suffered this destruction by Merenptah, and the several subsequent campaigns of Rameses III, which extended over much of the country. The complete silence about any such attacks strongly shows that the invasion of Canaan was subsequent to the last Ramesside campaign.

"But so far we are assuming, what is always tacitly supposed, that there were no descendants of Israel in Palestine between their migration to Egypt and the invasion of Canaan, which is so fully recorded. Yet a people who were so incessantly at feud with one another—the brethren of Joseph, of Aaron, of Korah, the slayers of Benjamin, the chiders of Gideon—are not particularly likely to have held together on all occasions, and never to have had family differences and separations. Such a 'stiffnecked and rebellious' people could scarcely hold together for many centuries, and migrate to and fro as one body, without some split being likely to occur.

"(c) There is then some possibility that a part of the Israelites remained behind in Palestine when the others went down into Egypt. That they roamed as nomads over the whole country is implied by their wandering from Hebron up to Shechem, and on to Dothan further north, on the edge of the fertile plain of Esdraelon (Gen. 37: 14-17). It is likely that the famine would not be so severe in that region, as it was nearer to the rainless Egypt, and it would be very possible that some branches might remain in the north while the others emigrated.

"(d) Another possibility is that a part of the Israelites in Egypt may have gone back again into Canaan soon after the famine. That they traveled there readily is suggested by the burial of Jacob at Machpelah (Gen. 50: 13); and there is absolutely no evidence that they all remained in Egypt until the Exodus. That there was a continuity of tradition in Palestine during all the Egyptian period is strongly shown. Not only was the cave of Machpelah known, but the burial place which Jacob bought in Shechem is also said to be known (Josh. 24: 32). How many Australians or Americans would know, in the absence of pictures, how to identify ground bought eight generations ago in England? Can we suppose that the hostile inhabitants of Palestine would maintain such inconvenient traditions, and obligingly tell—to a race who came to destroy them—what rights the invaders legally had? Such an assumed knowledge of the old landmarks strongly indicates that some of the family remained, or soon returned, to keep up the local knowledge; and so far either of the hypotheses c or d is supported.

"(e) There is yet another possibility of Israelites in Canaan. After the Exodus they prospected in the land, they wished to go up and occupy it, and they defeated the Canaanites in the south (Num. 21: 3); the latter fact is just at the end of the wanderings, but it appears from Hormah, being named then to be another version of the conflict soon after the Exodus (Num. 14: 45). That a portion may have succeeded in entering Palestine directly seems not at all impossible; and Merenptah may have chased after them in revenge for the escape of the main body.

"In considering these different views, the date of the Exodus and its relation to Egyptian history is a main factor. The principal consideration about this is the total absence of any reference to any Egyptian invasions after the Israelite invasion. Had the Exodus taken place in the eighteenth dynasty, as some suppose, there should be some mention in the Old Testament of the invasion of Rameses II, which extended over Moab, Judea and Galilee; of the invasion of Merenptah, which crushed 'the people of Israel'; of the invasion of Rameses III, which went through Judea as well as the north. The silence about these striking wars makes it extremely difficult to suppose that the invasion of Canaan occurred until after the last raid of Rameses III. But the brief period thus left for the age of the Judges is generally supposed to be a difficulty in placing the Exodus so late. It is impossible here to enter into details; suffice to say that by astronomical festivals the reign of Merenptah is fixed at about 1200 B. C. as its middle point; that the history of the Egyptian kings between him and Shishak well agrees with this date within a few years; that the genealogies of the Levites agree, also, within a few years of the same interval; and that the history of Judges, when carefully separated into its triple strands of north, west and east, shows a complete history of each division of the country, covering just about the same period as indicated by each of the other methods. We are thus led to see that there is nothing inconsistent with history in placing the Exodus under Merenptah, as is usually supposed; and that so there remains no difficulty in accepting the obvious conclusion that the last Egyptian raid was over before the twelve tribes entered Palestine in a body."

NEW DISCOVERIES AT POMPEII.

HAMPERED continually by the strained condition of its budget, the Italian government is carrying on excavations at Pompeii, and this locality remains an inexhaustible field of discovery. Under the direction of Signor Cozza, engineer in charge of the excavations, a whole Roman mansion has been discovered lately, the decorations and furnitures of which are in a perfect state of preservation. This house was a very important one. It occupied a whole isola, or city block, in the northern part of the town. The inside yard, as it was customary, is in a rectangular shape, very large, and surrounded on its four sides by a portico supported by eighteen Corinthian columns. Between these columns were found nine white marble vasques, four tables

resting on a base decorated with chimera's legs, and nine statuettes of Bacchus, fauns and cupids. The walls, painted black and red, are decorated at the top with a nearly intact cornice, richly ornamented. The different rooms, which open on the atrium, are embellished with frescoes of the highest interest. On the walls of the main hall is a frieze outstretching with the most exquisite taste and spirited execution. It represents scenes of everyday life, with winged cupids as performers. Many subjects of similar style have already been found in Pompeii, but none so well preserved and of such a delicate refinement.

One of these scenes represents a "wreath shop;" on one side the making, on the other side the sale of the wreaths is figured. Further is a "fuller's workroom." Two women are treading on the cloth, which is lying in a large bucket; a little further are seen two cupids stretching the wet cloth on a drying loom. Another cupid shows to the forewomen the work to do. At the right of this composition, and ending it, are two women folding the dry cloth which has been brought to them.

A "goldsmith shop" is not less interesting. A cupid is at the desk weighing on a scale a jewel which a rich lady customer, seated facing him, has just selected; while other cupids are hammering on a delicate anvil silver and gold objects. Next is a "chariot race." This fresco gives us a wonderful idea of the circus performances. Standing on their narrow chariot, drawn by antelopes, are four drivers. Dressed with colored vests, like our modern jockeys, they are pressing their speedy teams and striving with desperation. Besides the graceful frieze mentioned above, three separate fresco panels constitute the main decoration. Their dimensions are about a square meter, that is to say, a surface of about ten square feet. They represent various episodes of the Theban legendary history.

The first one shows the infant Hercules smothering the snakes which Juno in her jealous anger has sent against him. This episode appears on a beautiful coin of Crotona, and is well known to those familiar with the medallic history of the American revolutionary period. Taking his inspiration from the antique, Benjamin Franklin caused a medal to be struck at the Paris mint on which young America is personified by the child hero in his cradle strangling the two serpents. In the Pompeian fresco Jupiter is seated on a throne and contemplating with a radiant smile the infant hero's exploit, while Alcmena, his mother, hidden behind the god, follows with semi-anguished, semi-admiring eyes the progress of the struggle. The idea of the infant Hercules strangling two serpents is symbolical to the victory of light over darkness, of good over evil, and of free and united Hellas over barbarism and tyranny. This painting is particularly interesting, as it may be a copy of the famous composition by Zeuxis, mentioned by Pliny.

In the second picture Amphion and Zethus are represented taking revenge on Circe, who, after causing their mother, Antiope, to be repudiated by their father, Lycus, married him in her stead. They are in the act of tying her to the tail of a wild bull.

The slaying of Penthea is painted on the last panel. *Incensed* by Dionysos, whose worship this king had proscribed in his dominions, the mothers and sisters of Penthea have joined the Bacchantes. They have caught the unfortunate while he is watching them, and, intoxicated with mad frenzy, they kill him with their thyrses.

Generally all the pictures of importance exhumed at Pompeii are transferred to Naples, but an exception has been made in favor of the newly discovered frescoes. They can be admired at the site of their finding.—Cook's Excursionist.

THE PHYSIOLOGY OF COLOR IN PLANTS.*

THE principal coloring matters among the higher plants besides chlorophyl (leaf green) are those which have been grouped under the terms erythrophyl, xanthophyl, and anthocyan. Of these substances the chemical and physical properties of chlorophyl are best known, although its exact composition is yet undetermined. Not only is our chemical knowledge of the non-green colors very vague, but it is thought that a great number of different substances are grouped under each of the above and other color terms. Thus, for instance, anthocyan is made to include the large number of substances to which are due the red, blue, violet, and purple colors of such plants as the violet, beet, canna, rose, and amaranth. The coloring matters of plants may be in solution in the cell sap, as in the beet and amaranth; in irregular solid masses in the sap or protoplasm, as in nasturtium; or may be incorporated in the cell wall, as in logwood; or dissolved in minute oil drops suspended in special masses of protoplasm, as is the case with chlorophyl.

Chlorophyl is perhaps the most important coloring substance in the world, for upon this substance depends the characteristic activity of plants, the synthesis of complex compounds from carbon dioxide and water—a process upon which the existence of all living things is ultimately conditioned. It is by examination of light which has passed through a solution of chlorophyl that the greatest insight into its physical properties may be gained. If such a ray of such light is passed through a prism and spread out on a screen, it may be seen that there are several large intervals or dark bands in the spectrum. The rays of light which would have occupied these spaces have been absorbed by the chlorophyl, and converted into heat and other forms of energy. This energy is directly available to the protoplasm containing the chlorophyl, and by means of it the synthesis of complex substance may be accomplished.

Chlorophyl is a very complex and highly unstable substance, and during the absorption of light it is slowly broken down, but ordinarily it is rebuilt by the protoplasm as fast as it is decomposed. If, however, the chlorophyl and the leaf containing it are exposed to a light of such intensity that the chlorophyl is decomposed faster than it can be rebuilt, then damage must ensue, which, if sufficiently extensive, will result in the death of the entire leaf. Many plants are able to regulate the intensity of the light impinging on the chlorophyl-bearing masses of protoplasm by altering the position of the surfaces of the leaves. In others in which this movement is not possible—such, for example, as the leaflike duck weeds which float on the surface of the water—the intensity of the light received is regulated by alterations in the position and distance of the chlorophyl from the surface of the organ. In many plants growing in the bright glare of the sun a thickened cuticle or a heavy coat of hairs serves to protect the chlorophyl against the more intense action of the rays. It is also in this purpose of protection of the chlorophyl that many of the colors grouped under anthocyan find their chief function in the plant. In such instances the color is generally in solution in the sap of the layers of cells exterior to the chlorophyl, and light must pass through the coloring matter in order to reach the interior of the leaf. The number of plants in which the coloring substance is present in the cell sap or walls of the outer layers of leaves is extremely large, and embraces many well-known species, among which are the "foliage" plants of the gardener.

A very large category of plants have become adapted to living in the deep recesses of swamps and jungles, and in underbrush, where the direct rays of the sun never penetrate. Still another group is found upon the higher slopes of mountains in regions of low air temperatures. In both instances these plants need all the energy they may be able to derive from the light which falls upon them. They are not able by means of their chlorophyl to absorb all this light, and some of it would ordinarily be transmitted through the leaf without advantage to the plant. As an adaptation to this condition, their leaves are provided with layers of coloring matter, which are placed near the lower surfaces in such manner that any light passing the chlorophyl will be absorbed and converted into heat. It is often necessary for the plant to transport complex food substances from one portion of the vegetative tract to another along conduits which lie near the surface. On such compounds, as well as on chlorophyl, the blue-violet rays exercise a disintegrating effect. In quite a large number of plants, the lines of vessels in stalks, mid-ribs, and petioles of leaves are shielded from the direct action of such rays by means of external layers or bands of anthocyan, of some shade of red or purple. Whether the connection is a direct one or not, it is also true that many young and rapidly growing shoots exhibit marked reddish or violet colors at a time when reserve food is being conveyed to them in greatest quantity, and when the thin, tender tissues are otherwise so translucent as to allow the sun's rays to strike through them in a manner calculated to work great damage in the complex compounds in the young leaves. When the leaves mature and are not so pervious to light the colors may disappear. This is well illustrated by the behavior of the young leaves of rhubarb, cherry, and grape.

In plants with deciduous leaves, or the shoots which die down to the root stock each year, it is highly important that the material in the protoplasmic structures of the portion dying away should not be entirely lost, as it represents a large outlay of energy. As a matter of fact, in plants of this character the protoplasm, chlorophyl, and other nitrogenous substances are usually broken down and begin to be gradually withdrawn into the surviving portion of the plant about the time of formation of the first stages of the abscis layer which finally cuts off the leaf stalk, or about the time the activity of the herbaceous shoot begins to slow down. The disintegration of the chlorophyl would leave the leaf almost colorless and translucent, and the sun's rays would strike directly through it, resulting in the total decomposition of the proteids and a consequent waste to the plant, but during the decomposition of the chlorophyl there occurs, as a result or accompaniment of the process, the formation of much brilliant coloring matter of various shades, to which are due the brilliant autumnal tints of deciduous leaves. These coloring matters sustain the same general relation to sunlight as the other colors described above. They generally absorb the entire violet end of the spectrum, which, as has been pointed out, is the one which causes disintegration in the cells, as well as the lower red and infra-red rays.

It may be safely asserted that the above described occurrences of coloring matter are undoubtedly marked factors in the physiology of a large number of plants, without reference to the manner in which coloring screens and shields have arisen. It is also true, however, that a large number of plants contain coloring matters in the interior of organs or disposed in such other manner that they could sustain no possible relation either to light or to animals furnished with a color sense; still, many other occurrences of color are to be noted in which a physiological function is quite possible but is not proved. It must be admitted that in some instances physiologists have been led to conclusions concerning the use of colors quite as little justified as many of those reached by enthusiastic students of "adaptation to insect visitors." It is now somewhat generally admitted that color substances must very often be regarded as simply by-products in the chemical processes carried on by plants; a view which is undeniably valid of color masses in the interior of underground roots or tubers, or massive aerial organs, and also in a large number of instances in flowers. This latter application is further justified by the fact that some flower colors may change during the season without any relation to light conditions, insect visitors, or other ecologic factors.

* Prof. D. T. MacDougal, in Appleton's Popular Science Monthly.

RHODODENDRON SMIRNOWII.

THIS is undoubtedly one of the most interesting species of rhododendron which has been added to our collections of these plants in recent years. It is a native of the Caucasus, and seeds of it were sent to Kew from the St. Petersburg Botanic Garden in 1886. The plants thus obtained flowered for the first time in May, 1893, and have flowered with increasing freedom each year since. The species is in many respects quite distinct from any other rhododendron in cultivation, except its near ally and neighbor, R. Ungerni, which was found at the same time. Considering the size of the leaves, flowers, and inflorescence, it is remarkable for its dwarfness. Some of the plants at Kew, although ten years old, are only 6 or 8 inches high, and not one is more than 18 inches in height. There are, of course, plenty of species of rhododendron which at that or even greater age would be no taller than these, but none, so far as we know, producing trusses that in size and beauty compare favorably with many named garden varieties. This character suggests the possibility of obtaining by hybridization a new breed of rhododendrons of a more dwarf and compact habit than any of the garden varieties, and yet equaling them in the beauty of the flowers. Several crosses have, as we learn, been made at Kew between R. Smirnowii (as the seed bearer) and the finer garden varieties, and some distinct looking young plants have been obtained. The leaves of R. Smirnowii are narrow oblong or obvate, blunt at the apex, the largest being 5 inches long by 2 inches wide. When young the lower surface is covered with a white, felt-like covering which with age becomes pale brown. The upper side, too, is covered with a similar substance, but it is easily rubbed off, and the surface soon becomes glabrous. The leaf resembles more closely that of the Himalayan R. niveum than any other in cultivation. The flowers are borne in large, rounded trusses, the corolla being of a bright, rosy purple, and from 2 to 3 inches in diameter. The species is perfectly hardy. Our illustration is from a plant that flowered at Kew and is republished from the Gardeners' Chronicle.

RHODODENDRON SMIRNOWII—FLOWERS ROSY PURPLE, LEAVES DOWNY ON THE UNDER SURFACE.

THE IRON ORE INDUSTRY OF THE UNITED STATES.*

By John Birkinbine.

Iron ores have been mined or are known to exist in every State or Territory of the United States, with possibly three exceptions. In some States which in years past maintained an iron producing industry upon local ores, as Maine, New Hampshire, Vermont, Rhode Island, Delaware, South Carolina, California, Utah and Washington, the iron ore deposits are not now wrought, or if any small quantities of ore are obtained they are smelted in other States or used as a flux in silver smelting. In other States—Florida, Louisiana, Mississippi, Arkansas, Wyoming, New Mexico and Montana—either known iron ore resources await utilization or but small quantities of ore are produced. In still others, as New Jersey, New York, Pennsylvania, Maryland, West Virginia and Ohio, many local ores have been displaced by richer or more desirable ones obtained from other States or from foreign countries; although in several, particularly New York, New Jersey and Pennsylvania, large quantities of excellent ores are still mined. Other States, as Michigan, Wisconsin and Minnesota, mine large amounts of iron ore, only a small portion of which is used within their boundaries.

The iron ore mines of the Lake Superior region, located in the northern portions of the States of Michigan, Wisconsin and Minnesota, contribute a large proportion of the ore smelted in the United States. The percentages of the total ore output of the country which came from this region were: 51 in 1889, 56 in 1890, 53 in 1891, 59 in 1892 and 57 in 1893. While the Lake Superior region is to be credited with more than one-half of the total iron ore tonnage of the country, the quality of mineral taken from its mines is also above the average of domestic ores mined, thus adding to the commercial importance of this region. It is estimated that the iron ores extracted in this region during the period 1889 to 1893 made from 55 to 63 per cent. of the pig iron produced in the country in that period, provided all the ore mined from this district was smelted in the year it was produced, no account of stocks of ore on hand being taken into consideration. The mines on the upper peninsula of Michigan have produced the largest amount of iron ore, but in late years Minnesota has been advancing rapidly, and may compete with Michigan for pre-eminence. Wisconsin, although contributing heavily, is far behind Michigan and Minnesota in output. The bulk of the ores coming from the Lake Superior region are of the red hæmatite variety, but a part of the ore from a number of mines is hydrated, and ranked as brown hæmatite. However, but few of the active mines can be considered as producing the latter class of ore only. Several important mines supply magnetite in quantity, which is found in juxtaposition with red hæmatite.

The distance between the mines of the Lake Superior region and the majority of blast furnaces using their product demands that only the richer ores be shipped; consequently, deposits furnishing high grade ores which could supply in addition liberal amounts of leaner red and brown hæmatites, and apparently extensive veins of magnetite of inferior grade, are unwrought, or, if they were worked, are not now exploited except for the better ores. The mines in the Lake Superior region are located from 1,200 to 1,800 ft. above Lake Superior (or from 1,800 to 2,400 ft. above sea level), and are from 15 to 100 miles from the lake. Some of the prominent mines which have been exploited in late years are wrought "open cut," and the first development of the iron ores of the region was by open work. Most of the mines, however, are wrought underground, the various levels extending in some instances from 1,000 and even 1,500 ft. below the surface. In no other part of the country—and probably nowhere in the world—is iron ore mining carried on in a more thorough manner than in the Lake Superior district. The hoisting and pumping machinery and the compressor plants are generally of the most approved design. Power drills and high explosives are utilized to break the mineral economically. Electricity is introduced for lighting and for traction underground, and air compressed by water power machinery is conveyed miles to work hoists, pumps, drills, etc. In mining methods this district is well advanced; mine timbering and shaft sinking have received careful attention, and the steam shovel is employed to dig ore in the open cuts, or to load it on cars from stock piles. The ore, after being mined, is placed on stock piles or conveyed by railroad cars from fifteen to one hundred miles to various ports on Lakes Superior and Michigan, and there dumped into pockets in imposing shipping docks from which vessels are quickly and cheaply loaded. These vessels carry the ore to various points on Lakes Michigan and Erie, where expensive machinery lifts the ore from the vessels and conveys it on to stock piles or to cars which transport it to points of consumption even more distant. A comparatively small portion, yet by no means an insignificant amount, of this ore is smelted near where it is mined, or reaches the blast furnaces, using it by direct rail transportation. The shipping appliances have been a most important feature in permitting the ore from the Lake Superior region to reach distant points of consumption. Millions of dollars have been expended on shipping docks, and millions more on receiving docks and railroad terminals. Other millions still have been devoted to building and equipping magnificent steam vessels of large capacity. Among these the novel structures known as "whalebacks" were built to facilitate cheap transportation on the great lakes system. The importance of the Lake Superior region is best illustrated in the statement that since ore shipments were commenced in 1849 to the close of 1893 a total of over 81,500,000 tons of iron ore have been taken from the mines, the greatest annual output being in 1892, when 9,564,388 long tons were mined. Of this great total there have been won from the mines of the State of Michigan, since 1849, 69,500,000 tons; from Minnesota, since 1884, 7,000,000 tons; and from Wisconsin, since 1880, about 5,000,000 long tons.

Next to the Lake Superior district the most important contributor to the iron ore output of the United States is the region embracing Central Tennessee, Northern Alabama, and Northwestern Georgia, where red and brown hæmatites are mined in quantity, Alabama furnishing the greatest quantity, followed in order by Tennessee and Georgia. The red hæmatite ores are known as the Clinton fossil ores, and locally have designations of Red Mountain, dye stone, mountain, and river ores. They are inferior to the Lake Superior ores in iron contents, and are generally higher in phosphorus. Some of the deposits near the outcrops have been wrought open cut, but most of the mining is underground. For a considerable distance from the surface two varieties of ore, known as hard and soft ore, are mined, but as the workings gain in depth the hard ore predominates. The percentage of silicia and lime also varies greatly. The brown hæmatites are excellent, and compare favorably with others of the same class found elsewhere, making satisfactory foundry iron. The deposits are of unusual size, and are largely wrought by open cut, steam shovels being used to dig the ore, which is carried to washers to be prepared for use or shipment. The district has an advantage in the relative position of the ores and the coal seams. The red hæmatite especially lies convenient to coal deposits, which supply fuel for smelting the ores, while the Lake Superior region is hundreds of miles from any available coalfield. The brown hæmatites are generally more distant from coal, but many of the deposits are close to large timbered areas from which charcoal is made for blast furnaces, and a number of them are within convenient distances of good coal deposits. Prior to the civil war small charcoal furnaces were located in this district, local brown hæmatite deposits supplying ores which were of good character and easily smelted. It was not until after the war that the red hæmatite or Clinton fossil deposits were exploited, and then development was rapid, owing to the cheapness with which they could be mined and their close proximity to coking coal, particularly in the neighborhood of Birmingham, where the veins of red hæmatite reach their greatest width. This Clinton fossil ore, unlike the ore of the Lake Superior district, is not rich in iron, yielding on an average from 42 to 47 per cent. The Southern brown hæmatites, if properly washed, yield from 45 to 50 per cent. of iron, being often used as mixtures with red ores. The cheapness with which both ore and coal can be mined has combined to build up a large industry in late years, most of the iron produced being of foundry grade, but too high in phosphorus to be used in the Bessemer steel process. Some carbonates and a limited quantity of magnetite are used in this district. The production of iron ore in the Alabama-Tennessee region in 1893 was 2,301,421 long tons.

While producing one-half the total pig iron made in the United States, and rich in all four of the different varieties of iron ore, Pennsylvania did not furnish in 1893 more than about one-tenth of the total ore required for the State's blast furnaces in that year. The iron ores, though abundant, seldom contain as much iron as is demanded by the present advanced blast furnace management, and the State therefore draws largely on the Lake Superior region, New York, New Jersey, and various foreign countries. The State may really be divided into two, if not more, districts. West of the Alleghanies the Lake Superior iron ores are relied on entirely, only a small amount of native carbonate ores being mined and smelted. In the eastern district native red and brown hæmatites, as well as magnetites, are mined, and iron ore brought in from New York, New Jersey, the Lake Superior region, Cuba and other foreign countries is also used. In this district are situated the Cornwall Ore Hills, which are really three hills of iron ore, composed almost entirely of magnetite, of Bessemer grade, but rather low in iron contents, averaging from 40 to 48 per cent. This deposit has furnished iron ore for over 150 years, the amount taken from it in this time being estimated as over 12,500,000 tons to the close of the year 1893. Of this amount one-half has been taken out within the past decade. In 1893 the Cornwall Ore Hills produced more ore than any other single mining operation in the United States, the output, 439,705 long tons, being small when compared with the maximum—769,020 long tons in 1889. The brown hæmatites are found extending in a general northeast and southwest direction along the eastern side of the Blue Ridge and Bald Eagle Mountains and their spurs, while on the western side of the Blue Ridge occur the red hæmatite deposits, the magnetite mines being principally along the South Mountains. In 1893 the production of Pennsylvanian ores reached a total of 697,985 long tons.

New York State also produces the four different characters of iron ore, the bulk of the product being magnetite from the Lake Champlain district, in the northeastern portion of the State. A small amount of the same variety is obtained in the southeastern section, the latter also furnishing all of the brown hæmatite and carbonate ores, while the red hæmatite is mined in the northern central section. Approximately from one-half to two-thirds of New York's output of iron ore is smelted in the blast furnaces located in various portions of the State; the balance of the richer magnetites, red hæmatites and carbonate ores are sent to Pennsylvania. A small amount of foreign iron ore and limited quantities of Lake Superior and Massachusetts ores are also brought into New York. The Lake Champlain district is the most prominent producing region, and up to the close of the year 1893 had, since its first exploitation in 1804, produced about 18,000,000 tons of iron ore. The State of New York produced 534,122 tons of iron ore in 1893. The greater portion of the magnetite obtained in the State of New York is rich in iron, some of it being of Bessemer grade, while ore from neighboring openings is high in phosphorus. It is in New York that up to the present time the largest amount of concentrated iron ore has been produced.

The general line of magnetite deposits starting in northern New York extends to southeastern Pennsylvania, passing through the northwestern portion of New Jersey in a general northeast and southwest direction. With the exception of a small amount of ore which is a mixture of magnetite and brown and red hæmatite, the former predominating, all of the output of New Jersey is of the magnetic variety, the bulk of which is used by local blast furnaces or is sent to Pennsylvania for smelting into pig iron. While the iron ore mines of New Jersey have been active for over a century, and much of the ore is of excellent quality, the deposits are becoming deeper and more costly to operate on narrow veins, and some of them are practically exhausted. It is therefore probable that unless the leaner ores are utilized, or radical changes are introduced, New Jersey's iron ore mines will not contribute in the future as large an amount annually to the supply of the country as they have furnished in past years. New Jersey has several concentrating plants for enriching the lean ores, one of which is the largest in the country, but the quantity produced has not been sufficient to influence the position of the State, owing to the fact that the work has been largely experimental. The output of iron ore in New Jersey was, in 1893, 356,150 long tons.

Virginia practically consumes all of the iron ore which it produces, but little ore being either brought into or sent out of the State. Three classes of ore are produced, but the majority is of the brown hæmatite variety, in which the State takes first position; in addition to which small amounts of red hæmatite and a mixture of red hæmatite and magnetite are mined. The producing mines are generally situated in the southwestern portion of the State, extending in a general northeast and southwest direction along the Blue Ridge. In 1893, 616,965 long tons of iron ore were produced in Virginia.

Ohio and Kentucky furnish carbonate ores and their derivatives, all of which are consumed in local blast furnaces, most of the iron mining operations being found in the coal measures of the eastern and southeastern portions of the State. Although Ohio ranks next to Pennsylvania as a producer of pig iron, the domestic mines contributed but about 3 per cent. of the total iron ore smelted in the State, the balance coming from the Lake Superior region. The position of Ohio as an iron ore producer, owing to the comparatively poor character of the ores, has gradually declined. In 1893 only 68,141 long tons of iron ore were produced.

Missouri, like Ohio, has declined as an iron ore producer, due mainly to the practical exhaustion of Pilot Knob, one of the principal deposits. The two largest producers in Missouri have been Iron Mountain and Pilot Knob, but the output of the former has been greatly restricted in late years, while the latter mines but little ore. The total production of Iron Mountain has been about 3,500,000 tons, and Pilot Knob about 1,500,000 tons. With the exception of a small amount of brown hæmatite ore obtained in the southern central portion of the State, the iron ores produced are all of the red hæmatite variety, and are found in the eastern section of the State. The ore is generally of good quality, the red hæmatite yielding 50 to 65 per cent. of iron, averaging about 57 per cent. In 1893 the output of iron ore was 77,863 long tons.

Of the remaining States, Massachusetts and Connecticut produce excellent brown hæmatite, the Salisbury region in the western portion of these States furnishing 40,752 long tons in 1893. Maryland obtains from the vicinity of Baltimore a small amount of nodular carbonate ore, which is used in nearby charcoal blast furnaces, and also mines a limited quantity of brown hæmatite ore in the western, or rather northwestern portion of the State. The principal source of the ore supplied to the large blast furnaces of the Maryland Steel Company at Sparrow Point, near Baltimore, has been Cuba. West Virginia mined a small amount of brown hæmatite ore in the extreme northeastern section of the State, but, as in the western portion of Pennsylvania, the bulk of the iron ore for West Virginia blast furnaces comes from the Lake Superior region. North Carolina produces a small amount, generally from 10,000 to 25,000 tons, of magnetite ore (some of which is sorted by magnetic concentrators), the greater portion being smelted in the one active furnace at Cranberry, close to a large deposit of lean ore. A new furnace has been built, but is not yet in operation. Kentucky in 1893 won 36,714 long tons, principally brown hæmatite, with some carbonate and red hæmatite ore, nearly all of which was used in the blast furnaces of the State with ores from Missouri and Lake Superior. Texas blast furnaces are supplied by local deposits, all of the brown hæmatite variety, and yielding 40 to 48 per cent. of iron, producing 22,620 long tons in 1893; but in addition, in that year 3,000 tons of magnetite were obtained, though not shipped, in the Llano district, in the western section of the State. In the Western States the bulk of the iron ore produced in 1893 was brown hæmatite and magnetite, and with the exception of the amounts used in the blast furnaces of the Colorado Iron and Fuel Company, at Pueblo, Colo., and of the Oregon Iron and Steel Company, near Portland, Oreg., this ore was all employed as a flux in silver smelting.

In mining silver ore, principally in Colorado, a large amount of argentiferous iron ore is obtained, which does not contain enough of the precious metal to make it valuable on that account, and it is sold to the smelters as a flux in refining gold and silver ores. There is a number of large undeveloped deposits in New Mexico, Wyoming, Utah, Montana, California, Washington and other States, which will, no doubt, become active when local demand for such ores arises. There exist at various points on the Atlantic and Pacific seaboards deposits of magnetic iron sands, or rather layers of finely comminuted magnetite, which have, by the action of the waves, become partially separated from the siliceous materials forming beach sand. These deposits have been exploited to a limited extent by picking the magnetite from the mass by means of magnetic separators, but as there is usually a considerable percentage of titanium in the ore sand, and as the material must be made into briquettes for transportation and convenient use, but little of this ore has been employed in iron production. Some of these sands have been taken from the shores of Long Island Sound and Narragansett Bay, but at present the little now produced there is used by painters, and for other purposes than the production of iron. On the Pacific Coast deposits of this sand are wrought in Northern California and Oregon for the purpose of extracting the gold found therein, the iron ore being considered as tailings.

* Extracted from the sixteenth annual report of the director of the United States Geological Survey.—From the Colliery Guardian.

The California Fruit Transportation Company has perfected arrangements with the Southern Pacific Company and its connections by which it expects to ship considerable green fruit to England this summer. The shipment of green fruit in refrigeration to the markets of Europe last season was largely experimental. The Southern Pacific, Union Pacific, and Chicago and Northwestern lines will carry the train through to Chicago from Sacramento in 120 hours, and equally fast time will be made between Chicago and New York. It is expected to land the fruit in England in twelve days from the time it leaves Sacramento.

RECENT RESEARCHES UPON THE ROENTGEN RAYS.

THE researches published for the few past months on the ever throbbing question of the X rays do not seem to have much advanced the theory thereof, which still remains tributary to the documents of the first hour. The theory by which French physicists have sought to explain the phenomenon, in opposition to several theories in vogue in foreign countries, has nevertheless made great progress, since several of our masters have rallied to the support of it. It is not without pleasure that we have seen Lord Kelvin declare himself as convinced, after a long correspondence with Sir G. G. Stokes. Lord Kelvin does not give, in this regard, any new argument in favor of the idea. Perhaps he possesses more subtile ones than those to which we have alluded in the series of studies already published upon this subject. It will be recognized, at all events, that the collective opinion of the two illustrious British scientists is of itself alone an argument that is so much the better in that it is more tardy and that it has been more maturely discussed.

Lord Kelvin cites also, with praise, the measurements of Messrs. Perrin and Sagnac, which lead to the indication of a superior limit of the wave lengths of the X rays. The fact that fluorspar presents great opacity for these rays shows us that their wave length is less than 0·1 μ. Recent measurements lead to a limit that is twice feebler.

We shall revert presently to the researches that will

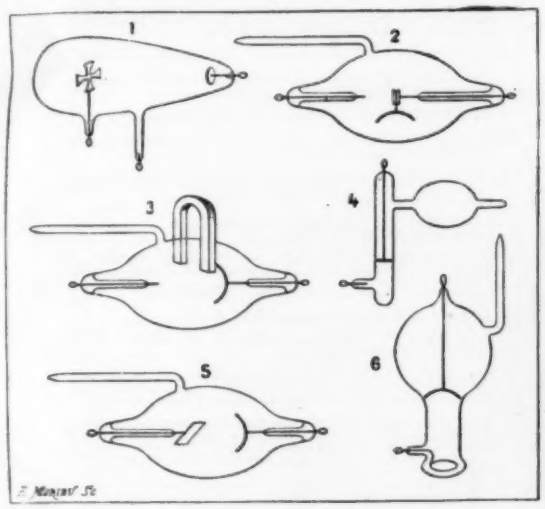


FIG. 2.—DIFFERENT STYLES OF BULBS FOR THE PRODUCTION OF X RAYS.

be necessary if it be wished to obtain a better idea of the nature of the phenomenon. We desire for the present to say a few words as to the experimental technic, which, during the last few weeks, has made great progress, and permits of attacking the innumerable problems concerning the new phenomenon with greater chances of success.

The production of the rays depends in the first place upon the bobbin employed, and especially upon its interrupter. The one most employed, owing to its simplicity, is the hammer interrupter, either in its old form or the one given it by Mr. Marcel Deprez. Unfortunately, this instrument gets out of order quite rapidly and necessitates an assiduous surveillance. The duration of its regulation, however, may be much prolonged by adopting the D'Arsonval-Gaiffe arrangement, which is represented at the extremity of the bobbin in Fig. 3. In the ordinary interrupter, two platinum pieces strike each other and produce an interruption of the current at every breakage of the contact. But the spark that forms at this place rapidly destroys the platinum, so that in a short time the pieces get away, and the operation becomes irregular. In the new arrangement, one of the pieces, actuated by a small dynamo, revolves continuously, so that the two surfaces become equalized and preserve the same direction for a long time.

The Masson wheel, which consists of a succession of sectors that are alternately conductors and insulators, gives great regularity in the interruption, and does not begin to lose its regulation until after a great number of hours of work; but it necessitates a separate motor, and this increases the cost of installation.

Finally, the Foucault mercury interrupter, which is generally used for producing strong sparks at the rate of two or three a second, is extremely regular in its running. Upon diminishing its inertia, it is possible to utilize it also as a rapid vibrator. In the production of the X rays, it gives good results, as has been shown by Mr. J. Chappuis. The interruption is very free when the surface of the mercury is covered with absolute alcohol that is frequently changed.

It is difficult to give general indications as to the length of spark that it is well to employ for actuating the tubes. Such length depends, before all else, upon

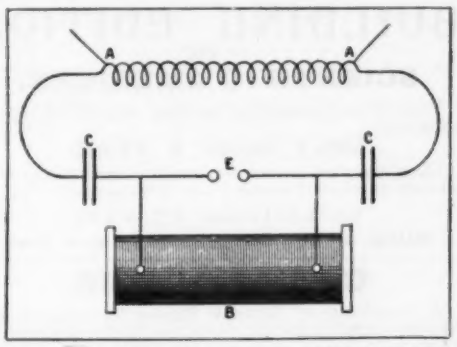


FIG. 1.—DIAGRAM OF THE D'ARSONVAL-GAIFFE APPARATUS.

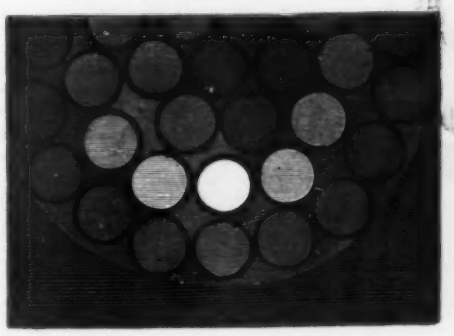


FIG. 4.—DISTRIBUTION OF THE LUMINOSITY OF THE ANTICATHODE DETERMINED BY MESSRS. IMBERT AND BERTIN-SANS.

the bulb, that is to say, upon the distance of the electrodes and the degree of the vacuum—in a word, upon the internal resistance of the tubes.

In the tubes constructed up to recent times, the discharge starting from the cathode has been received upon the surface of the glass called anticathodic. The source has generally been quite wide, as the concentration of the rays in the use of a strong intensity of current is apt to heat the glass until it becomes soft. After the cathodic discharge has struck the same part of the glass for several hours, the latter assumes a brown color and ceases to emit X rays. The source is thus gradually distorted, since the parts of the glass that give the strongest emission in the beginning are the most rapidly deteriorated. It is therefore of interest for one to be able to keep himself informed as to the state of the source at all times. To this effect, Messrs. Imbert & Bertin-Sans, of Montpellier, propose to apply against the bulb a bundle of glass tubes, at the extremity of which a photographic negative is taken. Fig. 4 gives a facsimile of such a negative. The state of the surface of the glass is thus seen at a glance, and one consequently limits the source to its most active parts through a diaphragm which is not necessarily circular. If one confines himself to feeble intensities, he may direct upon the glass the discharge of a concave cathode, which, in successive experiments, may be displaced by means of a magnet. With a plane cathode, one can even concentrate the rays by means of a non-uniform magnetic field, as has been shown by Mr. Meslin. Finally, after the example of Mr. Wood, it is possible to suspend the cathode from a sort of pulley and cause the tube to revolve beneath it (Fig. 2, No. 2). In this way the glass constantly changes its position in the cathodic discharge, while the source remains immovable.

From the description that has just been given of it our readers are acquainted with the tube devised by Mr. Colardeau (Fig. 2, No. 4), and which results from a series of improvements of detail. Mr. Goldstein had observed that the face of the cathode opposite the anode does not give cathodic rays if it almost entirely closes the tube. Rays of this kind are not only produced as a pure loss, but constitute a parasitic source which blur the image. Mr. Colardeau concludes from this that it is well to adjust the cathode in the tube, and this has led him to the remarkable results that we have already published. But the glass anticathode tubes do not give all that may be expected of a bulb. We have just said that the glass rapidly deteriorates. But this is not all: Messrs. Lodge, Hurmuzescu, Chabaud and other observers have remarked that the production of the rays depends in a strong measure upon the electrification of the anticathode. It is possible to receive the cathode rays upon a plate of metal communicating electrically with the exterior. It is then observed that the production of the X rays is almost null if this plate is a cathode, more abundant if it is insulated, and maximum if it forms the anode of the circuit. The X rays are therefore so much the more abundant in proportion as the cathodic rays follow the discharge better. It may even be said, with a certain likelihood, that the X rays are produced either by the cathodic rays or by the discharge. Thus would be explained why certain observers have claimed that the X rays always start from the anode. These remarks should necessarily lead to the construction of tubes in which the anticathode served at the same time as an anode. The first tube based upon this idea was tried in Germany and England under the name of "focus tube" (Fig. 2, No. 5). The anode, inclined at an angle of 45°, occupies the center of the bulb, and sends the rays in a direction at right angles with that of the cathodic rays. In these tubes the anticathode is of platinum. It results from this that it is impossible to cause the current to pass in a direction opposite that of its normal one, since the platinum rapidly evaporates and the bulb becomes covered with an internal mirror that increases its opacity. Messrs. Chabaud and Hurmuzescu have conceived the idea of substituting aluminum for platinum and of receiving the rays on the face of the anode opposite the cathode. As aluminum is transparent to the X rays, the discharge is scarcely weakened by the passage through the anode (Fig. 2, No. 6). Experimenters have gone still further. In Germany and the United States an endeavor has been made to close the tube itself by aluminum caps properly cemented. The rays then do not have to pass through the walls of glass, and good results seem to have been obtained with this arrangement. It must not be forgotten, however, that the greatest difficulty in the construction of a tube is to obtain a good vacuum, and that there is every interest in assuming perfect tightness. The cementing that replaces the direct soldering of the wires in the glass does not give very serious guarantees from this view point, especially when the tube begins to heat. We have been able to convince ourselves of the rapidity with which Mr. Chabaud's new tubes operate. At the last session of the Astronomical Society we were enabled to obtain, in eighteen seconds, a radiograph of a hand showing a bone entirely perforated, and yet the current employed was not sufficient to perceptibly heat the anode. When it is a question of the profile of the bone only, it is possible, with a current of sufficient intensity, to obtain a good result in one or two seconds.

The tubes specially manufactured with a view to the production of X rays are still quite costly, but they can be dispensed with, and one can utilize incandescent lamps whose filament has been burned up and that have become valueless. For exciting, however, it is necessary to employ very strong differences of potential, like those obtained by the use of the Tesla or D'Arsonval arrangement. The eminent physiologist in this case operates as follows: The lamp (Fig. 3) is suspended from a copper wire communicating with one of the poles of the oscillator, and the neck of the lamp plunges into a celluloid capsule filled with water and communicating with the other pole. The oscillations are furnished by a Tesla bobbin or by a Gaiffe-D'Arsonval arrangement, which is shown in diagram in Fig. 1. The Ruhmkorff coil, B, charges the internal armatures of two condensers, c c, which are connected by a spark exciter, E. The external armatures are closed upon a coarse wire bobbin possessing a strong induction. The system is the seat of oscillations of high frequency that are manifested at the extremities, A A, of the coil. Fig. 3 represents the apparatus such as it is constructed by Mr. Gaiffe. The condensers are in the base, and externally nothing is seen but the primary bobbin, the exciter and the bobbin that forms the secondary circuit.

For want of an old lamp there may be used a glass tube in which a vacuum is formed and which is capped by a rubber tube (Fig. 3), and which, like the lamp, is inserted in a capsule full of water. The rubber having been placed at the upper part of the tube, the small reservoir that it forms is filled with water, and the current is led into the two reservoirs.

The applications of the new processes are well known to our readers. We desire, however, to point out, among the most remarkable prints obtained, those made by Mr. Van Heurck, director of the botanical garden of Antwerp; those that Messrs. Eder and Valenta have just published in a very beautiful album; some photographs by Messrs. Chappuis and Meslin; a print of a new born child made by Messrs. Imbert, Bertin-Sans and Gagniere; and finally, the curious series of prints of all sorts made in the laboratory of the Optical Society.

The marine shells radiographed by Mr. Albert Londe at the laboratory of the Optical Society show with perfect sharpness their interior divisions of wonderful regularity and extreme delicacy. The committee of the Optical Society, moreover, has conceived the

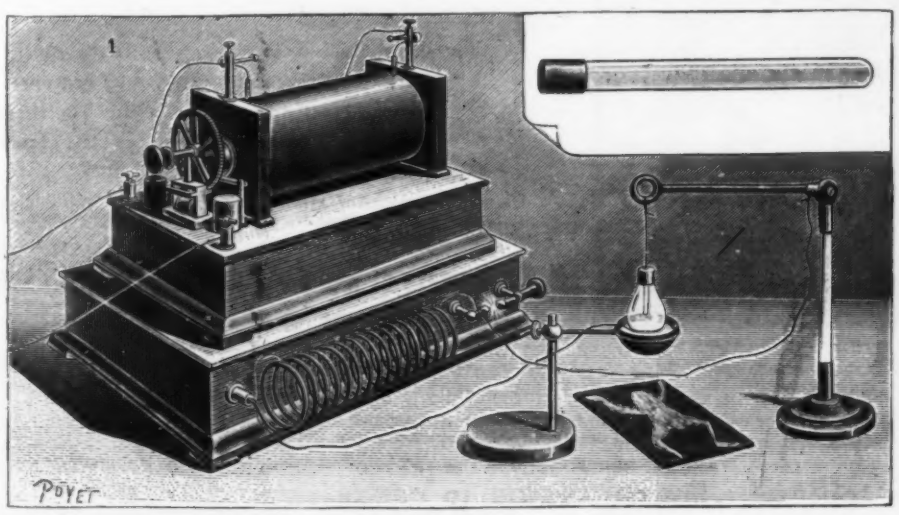


FIG. 3.—GENERAL VIEW OF THE D'ARSONVAL-GAIFFE APPARATUS FOR THE PRODUCTION OF OSCILLATIONS OF HIGH FREQUENCY. USE OF SUCH OSCILLATIONS IN THE EXCITATION OF A BULB FOR THE X RAYS.

happy idea of putting the X rays at the disposal of the public. Here are daily performed numerous experiments, of which the majority are designed to discover malformations, fractures or the presence of a foreign body in the organism. We have been able to see here the image of a ball lodged in the skull of an adult. The exposure had been an hour and a half.

We should have liked to say a few words as to a very singular extension of Prof. Roentgen's discovery, and which of itself constitutes a discovery which is perhaps a farther reaching one than the first. We refer to the production of radiations that traverse opaque bodies through the aid of phosphorescent substances without the intervention of discharges in gases. But this subject alone merits a profound study, and we hope to devote a special article to it, after investigations have advanced further. We prefer to terminate by mentioning a few experiments that remain to be made in order that we may inform ourselves more completely as to the nature of the new rays. We admit their optical theory, but we recognize the fact that definite and irrefutable proofs are still wanting.

Among Prof. Roentgen's precursors, Mr. Wiedemann is perhaps the one who came nearest discovering the new phenomena. In the ensemble of the energy in the interior of the tube he recognized the existence of two distinct phenomena, one being the radiation from the cathode and the other a special radiation which he called the "discharge rays." Employing thermoluminescent screens, that is to say, substances which, after absorbing a peculiar energy, give light when they are heated, he found that the discharge rays form a complex whole, some being absorbed by quartz or fluorspar, and others easily traversing these crystals. It is concluded from this, that in the interior of the tube there exists a very long spectrum of radiations of which we observe but a small portion externally, the glass having a wide absorption band in the ultra violet. One of the first researches necessary is deeper study of such radiations, guided by the new ideas as to the phenomenon. We shall, without much trouble, find a series of bodies having absorption bands such that, through superpositions, we shall isolate quite narrow regions of radiation. We shall then have oscillations that vary between narrow limits, and shall be able to clearly determine the properties of such radiations. Up to the present mixtures of diverse vibrations have been operated upon, and it has not been possible for the measurements to lead to very clear results. New forms of tubes will doubtless permit of observing such radiations outside of the conditions of their production. But the most important measurement that can be made is that of the velocity of propagation of the X rays. It is possible at present to observe these rays distinctly at 10 or 15 yards from the apparatus. This distance is doubtless too feeble to allow of the measurement of the velocity of the rays if it is equal to that of light; but it will be possible, at all events, to solve the question as to whether it is not a thousand times smaller.

However, if we succeed in reflecting the X rays in notable quantity, we shall be able to apply to them the method of measurement devised by Foucault, and there will be nothing to prevent the determination of their velocity with quite close approximation. It would probably be possible to measure the velocity of the X rays by comparing it with that of an electric wave along a wire, the rays lowering the explosive potential; but the researches may prove lengthy and tedious. They possess such an importance, however, that too much effort could not be devoted to them.—C. E. Guillaume, in La Nature.

A CONDITION OF THE MAXIMUM OF POWER OF CROOKES TUBES.

By JAMES CHAPPUIS and E. NUGUES.

THE power of a Crookes tube, actuated by a Ruhmkorff coil with a Foucault interrupter, does not increase for one and the same intensity of current, measured in the closed inductor, in the same time as the number of interruptions.

We have measured this power with the electrometer of Hurmuzescu placed at various distances, and caused the number of interruptions to vary from 3 to 50, by the displacement of an additional weight on the oscillator. The following numbers show that for the coil experimented with there is a maximum reached near 10 interruptions:

Number of Interruptions.	Time of Fall.	
3	27	47
6	23	—
10	20	24
25	30	34
50	37	42

The recent experiment on the emission of rays having a photographic power by means of fluorescent substances has led us to think that the visible fluorescence of the glass on the passage of the discharge may be followed by a kind of invisible fluorescence prolonging the photographic action. To verify this hypothesis we have made the following experiment:

On the stem of the oscillator we fixed a thick plate of copper in which there had been made a slit of about 1 mm. in width by 12 mm. in height; a sensitive plate was placed behind and parallel to it, at the distance of 1 mm., the source of light fitted with a diaphragm of 8 mm. on the other surface of the metal plate at the distance of 16 cm.

When the Foucault oscillator is set in motion, the rod carries with it, in its oscillatory movement, the slit over a course of 4 cm., and at each double oscillation there is produced a fluorescence. We have caused the speed of the oscillator to carry from 3 to 20 interruptions per second, and the time of exposure from 1 to 30 minutes.

If the useful fluorescence is instantaneous, like the discharge which produces it, we ought to obtain a distinct image of the slit; if, on the contrary, it lasts a certain time, we ought to obtain a band giving at each point an indication of the photographic power of the tube at a corresponding instant.

In all cases we have obtained a distant image of the slit and of the movable plate; it would therefore be sufficient to convince ourselves of the inaccuracy of our hypothesis, to photograph the stem of the oscillator in movement; it gives, in fact, on our proofs a shadow with very definite edges.

We deposit a proof obtained by 36,000 passages of the slit.

The power of the tube is hence instantaneous, like the discharge which induces the fluorescence.

It seems to follow, from this experiment, that the power of the tube should be proportional to the number of the discharges; but, on the other hand, the length of the sparks which strike between the two bulbs of an exciter falls from 21 to 5 cm. when the number of interruptions varies from 3 to 50.

There are then two phenomena which vary inversely, and which we must take into account for the production of the maximum power of the tube.

This maximum depends on the self-induction of the induced coil, and the conditions necessary for its production vary, for one and the same current measured in the closed conductor, with the coil employed. Experiment alone permits it to be determined.—Comptes Rendus, cxxii.

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